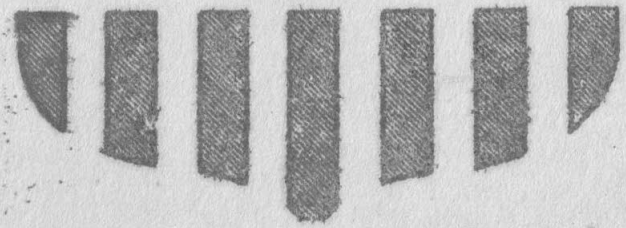
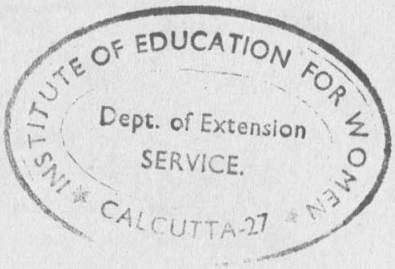
UNITED STATES OF AMERICA

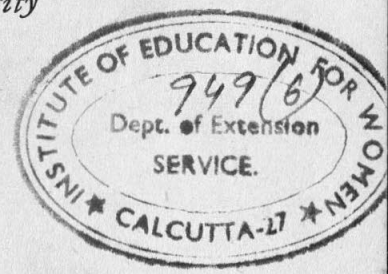


New Directions in Science Teaching



NEW DIRECTIONS IN SCIENCE TEACHING

A Report of a Cooperative Project in Seventeen Secondary Schools with the Bureau of Educational Research in Science Teachers College, Columbia University



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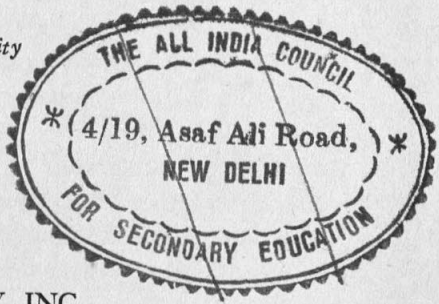

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NEW DIRECTIONS IN SCIENCE TEACHING

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PREFACE

The Bureau of Educational Research in Science was authorized by the Dean of Teachers College, Columbia University, and established in September, 1935, to initiate and carry forward studies in the teaching of science at the secondary-school level. It was given financial support by a grant from the General Education Board. The funds were used to maintain a resident staff; to employ experts who came to the workshops as consultants; to defer expenses of teachers from the cooperating schools who came to Teachers College to participate in the summer workshops; to pay for necessary travel; and to pay for necessary office expense.

Housing for the project and the services of the Administrative Officer were furnished by Teachers College. In addition, many members of the staff of Teachers College and the Graduate Faculties of Columbia University gave freely of their time when asked for advice on the work in progress. The Bureau was regularly advised in its activities by a committee from the Graduate Faculties of Columbia University, appointed by the President of the University.

Experts from the several branches of the natural sciences and from the fields of psychology, sociology, anthropology, philosophy, literature, school administration, and education met from time to time to counsel informally with members of the Bureau staff and the workshop personnel.

The work was furthered by the cooperation of various public schools, colleges, and universities, which gave leave to certain members of their staffs to work as research associates on phases of the project. The administrative staffs of the cooperating schools were always cordial and were especially helpful to the

teachers in making administrative changes necessary to the innovation to be undertaken. The cordiality and enthusiasm on the part of administrators for the work helped the teachers to get assistance and sympathetic recognition in their own schools from other science teachers and from teachers in other areas of interest.

The Bureau served for a number of years as a center for give and take among scientists, classroom teachers, and other educators, who came to know one another and learned to work together on issues and problems of general education. The names of staff members, cooperating teachers, and consultants are given in Appendix B. The authors feel that they speak for all as they acknowledge their gratitude for mutual help and assistance.

The authors of this report are happy to recognize their very great indebtedness to two staff members with whom they were associated for several years. Miss Charlotte V. Meeting, now with McGraw-Hill Book Company, was formerly Editor for the Bureau of Educational Research in Science. Her practical and painstaking attention to the Bureau's publications made possible a high standard of editorial excellence in all its publications. In the preparation of this volume she has assisted in making judgments on what to put in and what to leave out and in arranging and editing the manuscript.

Dr. Elsa M. Meder, now with Houghton Mifflin Company, was a valued counselor for members of the Bureau's resident staff as well as for the cooperating teachers. Her keen insight on matters of planning and evaluation was indeed a most important resource. In the preparation of this Report she assisted in laying out the outline and has read and offered suggestions on all the manuscript. Chapter 8, "Man's Place in the Universe," was written by her.

ANITA D. LATON
SAMUEL RALPH POWERS

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INTRODUCTION

By Samuel Ralph Powers

The background for the work of the Bureau of Educational Research in Science was first stated in an article entitled "Educational Values of Science Teaching" in the *Teachers College Record* for October, 1930. The preliminary statement of working plans was drawn up in a memorandum entitled "A Program for Science Education," which was presented to the General Education Board in April, 1934.

The Bureau of Educational Research in Science, like several other agencies, was concerned primarily with the education of young people in accordance with their needs. Secondary education is now nearly universal, but the science courses usually offered in secondary schools are those that were introduced at a time when secondary education was highly selective. These courses do not meet the needs of the great majority of young people in our schools. Now, school organization and school attendance provide the means for helping all our young people to prepare for active, intelligent participation in the affairs of today; and more experiences with science, but of a different kind from those offered in the usual specialized courses, should be provided for *all* students.

The advances in the natural sciences have brought about, and are continuing to bring about, changes that have far-reaching effects on the lives of youth and adults. Problems, such as conflicts between individuals and groups of people, mental and physical disease and ill health in congested centers of population, unemployment, destruction and misuse of resources, exploitation of ignorant and uneducated persons through the use of mass

communication media, had their origins in, or were very directly affected by, developments in science. Nevertheless, science in secondary schools has continued to be a cluster of discrete subjects, taught with major emphasis on abstract formulation of theory and providing but little firsthand experience with phenomena related to issues that could be recognized as important by young people. Consequently, the staff of the Bureau sought ways to help teachers to broaden their knowledge of science and to help them learn to use the content and methods of science in dealing with personal and social issues that have been raised largely as a result of advances in science.

Tradition and the demands for college preparation have dominated both content and methods in the curricula in the past. It was not contended that curricula so dominated are necessarily poor in whole or in part, especially when viewed from the standpoint of the purposes for which they were designed; rather it was assumed that curricular materials and methods of teaching consciously selected because of immediate significance to human living will better serve young people than those in which such a significance, if present at all, is incidental. Interests of the Bureau were thus centered on science teaching designed to contribute to general education. These interests carried the work beyond the program of science teaching narrowly considered, for science in general education was not considered as something apart from other aspects of school experience. The entire project was set in the framework of contemporary theories of general education for young people in high school. Three major lines of work were followed in sequence.

THE WORK OF THE BUREAU: FIRST INTERVAL

The first interval of the Bureau work, which began in 1935, was a period of exploration, during which the primary effort was to determine what scientific knowledge is requisite to an understanding of problems that people face and how that knowledge

can be used for their resolution. Specialists in several fields of learning—biology, chemistry, physics, philosophy—worked in close cooperation with those responsible for the initiation and direction of the Bureau project.[1] These specialists were selected because of their interest in the social implications of science. Some took leave from their regular positions and worked full time for one year. Others were on part time, dividing their work between the Bureau and the positions in which they were regularly employed.

The broad fields that engaged the attention of the Bureau staff —individually and collectively—included the structure and development of the physical universe, the organization of the living world and its changes through time, the interrelations of living things, and the control and use of matter and energy. As a result of study, thought, and synthesis of information in these areas, materials were assembled for several books which were designed to provide a sound perspective and appropriate illustrative content useful as a part of general education for all.[2] The issues and problems treated in this writing project included (1) life and environment, with particular attention to the maintenance of a high level of biological production, (2) the technological utilization of materials and energy and the potentialities of our resources for abundant production of consumer goods, (3) the control of organisms injurious to man, plant parasites, insects, and rodents, and (4) the hereditary pattern of the human organism with basic information about reproduction, growth, and development, and genetic likenesses and differences among men.

It should be clear that the authors of these several volumes were not concerned primarily with the preparation of syllabi or

[1] The specialists of this first interval and the resident staff members of later intervals were appointed as research associates. Their names are listed in Appendix B.

[2] These books were published under the series title "Science in Modern Living" by the Bureau of Publications, Teachers College, Columbia University. The authors and titles are listed in Appendix C.

with the definitions of fundamental facts to be learned. They were concerned with helping their readers, especially teachers, to clarify their own thinking about important matters. The prime purpose was to enrich the background of the reader. Books that provide such enrichment broaden vision and knowledge and furnish a necessary foundation for improved teaching and learning.

THE WORK OF THE BUREAU: SECOND INTERVAL

The goal of the second interval of the Bureau was to prepare teaching suggestions on how to lead young people to a clearer understanding of society, of the social function of science, and of their individual needs and interests. Expert classroom teachers were selected as staff members for this phase of the work, which began in September, 1938. Some of these teachers took leave from the positions in which they were regularly employed and spent a semester or a year as resident Bureau members; others came for one or more summers.[3]

For some of the new staff members, there were opportunities to participate in discussions with those who had worked in the Bureau during its first phase. For all, there were available the books, articles, and memoranda prepared during the first interval. These discussions and readings fostered an interest in, and an appreciation of, the social function of science.

The publications of the second interval became known as *Suggestions for Teaching*.[4] Insofar as practicable, they were descriptions of work actually carried out by successful teachers. The reader then could become a vicarious participant in the work that was reported. The *Suggestions* usually followed a pattern which included (1) a brief overview of an area of study

[3] Their names are listed in Appendix B.

[4] Some of the *Suggestions for Teaching* were published by the Bureau of Publications, Teachers College, Columbia University, in the "Science in Modern Living" Series. Others were printed in magazines, and some were distributed in mimeographed form. The titles and authors are given in Appendix C.

and teaching and of knowledge found to be pertinent to it, (2) a list of possible outcomes that had been achieved in whole or in part in practical situations, and (3) a list of questions and problems that had arisen in situations which the authors described. These more or less preparatory measures were followed by (1) description of procedures actually used or judged appropriate for introducing the area of study, (2) activities found or judged to be useful in carrying the study forward, and (3) suggested methods and instruments for evaluating the success of teachers and students.

The second phase of the Bureau's work was concentrated in two academic years and the intervening summer (1939). During that summer, a number of science teachers were invited to a "workshop" to advise and assist in the preparation of *Suggestions for Teaching*. This workshop not only was a valuable part of the work of the second interval but was the forerunner of the three workshops that were an essential feature of the third phase and, in a sense, proved to be a training ground for them.

THE WORK OF THE BUREAU: THIRD INTERVAL

The work of the third interval was essentially an effort to translate the work of the first and second intervals into actual classroom practice. It was carried on as a cooperative enterprise between the Bureau of Educational Research in Science and a number of selected schools. Originally, twelve schools or systems participated; as the work progressed, five more schools joined in the cooperation.[5]

Cooperating Schools

Public schools taking part in the project were Cincinnati, Ohio, High Schools; Cleveland, Ohio, James Ford Rhodes High School and John Marshall High School; Des Moines, Iowa, High Schools; Detroit, Michigan, Edwin Denby High School;

[5] A description of the schools is given in Appendix A.

Glens Falls, New York, Glens Falls High School; Hammond, Indiana, George Rogers Clark High School; Indianapolis, Indiana, Arsenal Technical Schools; Los Angeles, California, Susan Miller Dorsey High School; New York, New York, The Bronx High School of Science; Oak Park, Illinois, Oak Park and River Forest Township High School; Philadelphia, Pennsylvania, Olney High School; Trenton, New Jersey, Central High School; Winnetka, Illinois, New Trier Township High School.

The private schools included Bloomfield Hills, Michigan, Cranbrook School for Boys; Greeley, Colorado, Colorado State College of Education; New York, New York, Fieldston Ethical Culture School; New York, New York, Lincoln School of Teachers College.

Arrangements for the cooperation were made through conference with the chief administrative officer in each of the selected schools or systems. One science teacher from each school was asked to serve for the duration of the project (three years) as a nonresident member of the Bureau staff.[6] This teacher assumed responsibility for the work that was to be undertaken in the school or system in which he was employed. The nonresident members assembled at Teachers College during summer sessions and worked together in planning for the school year that was to follow. These summer workshops were the planning centers for the cooperation and were an essential part of the larger undertaking carried on to help teachers achieve a working understanding of the ways in which scientific methods and discoveries are affecting life of today.

The body of this report describes some of the activities that went on in the cooperating schools during the last three years of the project. A preliminary statement of the purposes, plans, and method of working is given here to show in a general way the point of view that guided the staff and cooperating teachers and at the same time to show the background of experience that was drawn upon while this point of view was evolving.

[6] A list of cooperating teachers is given in Appendix A.

Purposes and Plans

The representatives from the schools selected for the cooperative enterprise assembled first in 1940, though there were among them some who had been in attendance in the workshop of 1939. Reports on experiences of the preceding summer were available, together with teaching suggestions and other material completed or in preparation by resident members of the staff and from other sources. During the planning of the summer's work, the discussions of the cooperating teachers centered directly upon their own needs. There was general agreement that the chief need was for better understanding of their own communities and of the impact of the local situation on the young people in their classes.

Meeting in small groups and with the assistance of able consultants, the teachers worked to extend their own education in selected areas and also to prepare teaching materials suitable to the maturity levels of their classes. All were interested in a realistic approach to the problems of evaluation, especially in methods and instruments that would help them to detect both their failures and their successes. Each one assumed responsibility for adapting the summer's work to his own school and for seeing that the plan was actually carried out. In most instances, the cooperating teacher planned to enlist the help of his colleagues in the school in which he was employed and, thus, to extend the influence of his work throughout the school.

In general, the plans followed in the three summer workshops were similar. The planning was guided by an assumption that the function of the school is to present opportunities for young people to achieve a "useful" education, that is, an education recognized by the students as rooted in their own needs. The term *useful* was never interpreted narrowly to mean *trade education* but broadly and in terms of the teacher's experience and experience of his students. This assumption led to the community as a source of information and education, for it is in the community

that students and their parents operate, where their pertinent social and personal problems may be identified.

The Method of Working

The selected teachers came to the workshops with at least a partial plan of work. In most cases, the plans had been discussed with the administrators in the schools in which the participants were employed and, in many cases, were based on work already in progress. The members of the staff held themselves in readiness to assist individuals, to take leadership of groups working in the fields of their own special interests, and to provide other resources as needed. There were general meetings, special lecture sessions, group conferences, and field trips. Opportunity was open for participation in college and university courses when the need for such participation was recognized.

Scheduled general meetings were held in the mornings, and there were some other meetings which all attended. Each participant described his own school and the community it served, calling attention to the relations existing between the school and the community and problems that locally engaged public attention. He described the student body, recognizing variability in interests and aptitudes. Following this general description, he gave his own plans for the summer and for the ensuing year. There was discussion of Bureau publications and of special studies in which progress had already been made. A prominent feature of these meetings was the discussion of each participant's interests. When these interests were voiced, there followed discussions, often led by regular members of the staff. When the need arose recognized authorities from outside the regular staff were invited to give counsel and advice.[7]

There were many group conferences. Some of these carried on from one year to the next with study of the same topics. In some instances, the topic was dealt with in one or two meetings.

[7] A list of consultants who participated in the workshops as experts in particular areas is given in Appendix B.

Some of the continuing studies were of health education, physical development and changes through the human life span, scientific methods, housing, intercultural relations, community resources and community planning, evaluation, integrated courses, and economic trends.

In the group conferences, attention was centered on efforts by the participants to extend their own education in areas judged to be important to them, not only as teachers, but also as interested adults living in the world of today. They also pursued studies of how to modify teaching practices so as to make possible greater success in helping young people to achieve useful education.

Field trips in general grew out of the group conferences. The discussions of health, housing, intercultural relations, and community resources and community planning were supplemented by field observation and study of how these matters were dealt with in New York City.

The social life was an integral part of the total experience. It included meetings at lunch and dinner, and other informal gatherings, visits to the theaters, churches, parks, and cultural centers. The meetings were both professional and avocational and characterized the workshop as an opportunity for people with vital common interests to meet and discuss, as mature individuals, the things in which they were most interested.

The major areas of study undertaken in the workshops were of general interest to all, but the intensity of work in each area varied with the needs of the participants. Immediate needs were determined by considering the relation of the particular areas of study to the interests and problems in the communities from which the teachers had come and to the plans for work which each one was developing for the ensuing year.

In the workshop situation in which teachers of like interests were working together to advance their understanding of important issues and problems, the work was powerfully motivated and the long-time effects of such study were indeed far-reaching. In his evaluation of the work, one member of the group ex-

pressed an opinion that seemed to have been shared by all when he said: "After one has worked through an experience such as this (referring to one of the studies in which he had participated), he will never again teach as he did before."

Questioning the Administrative Plan of the High School

As the cooperating teachers advanced in their studies, it became increasingly evident that the usual administrative plan of the schools in which they were employed was not well suited for the teaching they wished to do. It was obvious that the studies undertaken by these teachers were broader than the usual subjects and that some provision must be made in the schedule of the school if such studies were to be included in the curriculum. It was recognized, too, that these broader studies would be carried on most effectively if teachers from several areas of specialization participated. Short class periods imposed an undesirable rigidity, and there was need for the kind of freedom that would allow for field trips.

Administrators Visit and Participate

As a measure for fostering close relationship between the Bureau and the cooperating schools, administrative officers from the schools were invited to come to the workshops to observe and to participate in their activities.

Eight administrative officers from as many schools attended during one summer and took part in discussions. These men prepared a statement that was, in effect, an evaluation of the workshop from the point of view of its contribution to furthering education in the cities from which they came. They agreed that educators must try to prevent the reappearance of the youth problem which existed during our last depression among the 18- to 21-year-old group. They urged that the present students of our high schools receive a better integrated education than that of their predecessors in school. They recommended that education take account of science and technology as a means of

preparing young people to deal with problems of human society and to live in an expanding economy, which will substitute abundance for scarcity in the utilization of the world's resources. They recognized the need for a new type of preparation for prospective teachers and a continuous retraining of teachers in service. They recognized that measures for furthering such teacher education could be provided only at considerable cost and advised that this be shared by local, state, and federal governments. Following their observation and participation, the administrators endorsed the workshop as a valuable educational agency.

College Teachers Attend and Take Part

On initiative of officers of the General Education Board, selected teachers from southern schools and colleges, both Negro and white, were granted fellowship aid for attendance in summer workshops. One particularly fruitful experience was provided for a small mixed group that came in early spring for a period of study. After a short interval in New York, the group left on a tour of visitation, which included most of the cooperating schools.

After these visits, the fellows returned to New York and continued their studies in the Bureau until the end of the summer session. Out of this and other related experiences, the Negro teachers laid plans for an organization of science teachers to be called the *National Institute of Science*. This organization has continued as an active agency affecting the scientific work of Negroes, with a very active section concerned with the professional education of Negro teachers.

EXTENT OF THE BUREAU'S INFLUENCE

There is no way to tell how many people came directly and indirectly within the scope of influence of this work. It was carried on as a part of Teachers College, Columbia University. Dur-

ing the progress of the work, many teachers and prospective teachers studied in the Department of the Teaching of Natural Science, and many more studied in other departments of the College. Professors in other departments gave advice freely, participated as consultants in the workshops, and in other ways took cognizance of work under way.

The influence on science teaching and on general education of the many related activities carried on under the comprehensive plan of the Bureau of Educational Research in Science can never be accurately evaluated. There was through it all a continuing study of society, of needs and interests of youth, and of how teachers may carry on more effectively in their work. The total plan evolved, with advice and guidance of scientists and educators, out of careful studies of trends in our society and in education. The workshop, together with the cooperating schools, provided a means for testing out in practice various elements of this total plan.

To those of us who watched the teachers and schools at firsthand, the experience was heartening and exciting. There is abundant evidence that those who participated in this cooperative endeavor gained in awareness of the limitations of public education and in ability to make corrections of them. It is hoped that the printed word can carry some of the enthusiasm and stimulation to other teachers in the field.

SECTION I. Teachers Gain New Perspectives and New Knowledge

CHAPTER 1. Study of the Community

The general idea that study of a community is basic to effective teaching in that community is, of course, not unique with the Bureau of Educational Research in Science. Schools are shaped by their communities; at the same time, schools through teachers and students, now and in the future, shape their communities. Any adult who knows the unique features of his community, the difficulties in providing food, shelter, work, education, and recreation for its members, and its relations with other communities and the rest of the world is challenged to do his share intelligently in making it a better place in which to live. When that adult's interests are tied up with the coming generation, as are those of teachers, he is challenged further to help young people plan their lives and develop the understandings and skills that will enable them to live happy, rich lives in the communities of their choice. The modern philosophy of education negates equally the ivory-tower concept of education and the cog-in-the-wheel philosophy that makes schools passive recipients of outside influences.

Each of the cooperating teachers, early in his work with the Bureau, made a study of the community in which he was teaching and in which his students would probably continue to live. No two communities are identical; no two teachers are identical in their background and their approach to teaching problems. There was wide variation, therefore, in the aspects chosen for study by the individual teachers and in the uses to which they put the information collected. Some obtained all their information about their communities from published reports; others sup-

plemented the reports by firsthand observation and by questionnaires directed to students, parents, and other persons in the community.

All the teachers achieved for themselves a better orientation to their own roles in the community. This better orientation was expressed in a variety of ways in their teaching. Some teachers, because of necessity or choice, retained already existing topics and courses but enriched them with illustrations drawn from the immediate environment. Others introduced new units of study of the community. Still others introduced topics or courses that were focused on direct study of community problems.

No conclusions can be drawn as to what any individual teacher in any particular community should do. The conclusion can certainly be drawn that any teacher who thoughtfully studies the community in which he and his students are living will himself be a richer personality and will express his own orientation in better teaching.

KINDS OF COMMUNITIES SERVED BY THE COOPERATING SCHOOLS

The communities served by the cooperating schools varied as to economic and cultural levels, although the majority were probably somewhat above average for the United States as a whole.

In most of the schools, a study of the students' families and of their own plans showed a fair degree of stability. The young people expected to grow up, marry, establish their homes, and work in the city or region where they were going to school. In Trenton, the city itself was the community thus defined. In Los Angeles, the whole of southern California represented the area in which the students expected to live and work. At Cranbrook, the local community (Bloomfield Hills, Michigan) was relatively unimportant for many of the boys whose homes were at a distance from the school and whose parents were engaged in large

manufacturing and distributing industries. In a very real sense these families had as their community the industrial region of the Middle West and, indirectly, the whole nation and the world.

There was wide variation in types of communities as well as in size. They ranged from the highly industrialized cities of Hammond and Detroit to the agricultural and mining regions about Des Moines and Greeley. With the exception of those in Bloomfield Hills, Greeley, and Glens Falls, all the schools were located in large cities. The racial and national composition of the population was of special significance in such cities as Detroit and Indianapolis.

COLLECTING INFORMATION ABOUT COMMUNITIES

All the teachers found that the United States Census reports for their respective states gave basic information about their communities: size and composition of population, kinds of industries, disease and death rates, and per capita wealth. In most places, chambers of commerce provided information about housing, industries, and recreation. City and state health departments gave statistical reports of illnesses and deaths. Questionnaires and home visits brought information about unreported illness. In a few cities there were planning commissions, which had made extensive surveys of the community and the region.[1] In Cincinnati, it was found that a privately endowed organization had made a summary and interpretation of material from the Census about the population of the county.

In some schools, Glens Falls, for example, the cooperating teacher collected the information about the community and made it available to interested members of the school. In other

[1] Since 1943 the number of city planning commissions has increased, and many teachers today can gain from them a wealth of information of value to them and to their students.

schools, as Cranbrook, two or more teachers worked together. In Detroit, a committee composed of teachers and students from Edwin Denby High School analyzed the problems of the community. In Hammond, part of the community survey was made by the school nurse. She collected material concerning number and kinds of illnesses reported to the city health officer and published in statistical reports from his office and from that of the state department of public health. In addition, she interviewed students and parents, at school and in their homes, and gathered information about illnesses, often unreported, of the members of their families.

In Indianapolis, a committee of teachers carried on a community study over a period of two years. Sixteen areas of community life were investigated: history; community setting and geography; natural resources; foreign-born and racial groups; health and sanitation; safety; housing; public welfare and assistance; educational and cultural facilities; religion; industry, occupations, and employment; government; crime; recreational facilities; public informants, such as literature, newspapers, and radio stations; and military areas. The stated purposes of the study were (1) to give the teachers a better understanding of the community in which their students live and of the problems which they must face, and (2) to determine what material concerning the community should be incorporated in courses of study in order that students may use the resources to better advantage.

One interesting point concerning this survey was that, although initiated by a science teacher, it was a school, rather than a departmental, project. In addition to teachers from all the science departments, the committee included the school-industry coordinator and teachers from the departments of English, social studies, agriculture, building trades, and physical education.

In Des Moines, the study of the community was even more broadly based than in Indianapolis. Several groups of citizens had made sporadic and uncoordinated attempts to find out more about their city. In 1939 a central organization was formed for

the purpose of pooling time and results of these efforts. Representatives to this organization came from about 50 out-of-school groups—service organizations, professional organizations, women's clubs, religious groups, chamber of commerce, and others—and from various clubs and organizations of school people.

Fourteen areas of life-activities were selected for study in Des Moines: business, education, consumer education, government, health, homes, industry, intercultural relations, occupational opportunities, practical and fine arts, public welfare, recreation, religion, and safety. A committee was appointed to explore each of these areas; each committee consisted of both school people and representatives from community organizations. Data were collected by questionnaire and by personal interviews with members of all groups in the community that contributed to each area of living. For example, the committee charged with studying the health resources of Des Moines made contacts with a total of 27 different agencies, including hospitals, health centers, county and city medical, nursing, and dental associations, Boy Scouts and other youth organizations, committee on health of the Parent-Teacher Association, Salvation Army, and veterans' organizations. The committee studying community resources in the field of intercultural relations visited 16 organizations: the American Legion, Daughters of the American Revolution, a settlement house, the National Association for Advancement of Colored People, and various Italian, Jewish, and Scandinavian organizations.

All the work was focused on usefulness of the community resources to the schools. Lists were prepared of excursions that students might make to learn the work of the various agencies, of speakers, visual materials, and demonstrations that could be provided to the schools, and of ways in which students might participate in community activities. All this information was put together in a handbook, together with addresses, telephone numbers, and other practical information a teacher would find convenient in work with his class that involved any of these agen-

cies. The handbook was to be corrected and enlarged from year to year.

The primary purpose of the Des Moines survey was better understanding by students and teachers of the community in which they lived. It served an additional purpose in that it gave many individuals and groups in the community a better understanding of the schools and the ways in which the whole community could participate in the educational process.

USES MADE OF COMMUNITY STUDIES

Probably none of the cooperating teachers taught exactly the same way after making a study of his community as he had taught previously. New illustrations were used in teaching traditional topics, new topics were introduced, and new courses were organized. Examples of these innovations are given in the remaining pages of this chapter.

Cranbrook Regional Study Influenced Chemistry and Economics Courses

Cranbrook draws students from families who own and manage some of the great industries of the Middle West. Knowing this, science and social studies teachers decided that students needed a comprehensive picture of the interchange of materials throughout the world, since this interchange is the basis of our industrial economy. They felt that students should gain, also, an understanding of the problems of conservation, of labor, and of economic adjustments dependent upon exchange of materials.

Some of these ideas were introduced into the regular science courses, but at the end of a year a new combined course of chemistry and economics was developed. The new course was taught by teachers in both fields. It is described on pages 64–66. These teachers, with the aid of other members of the Bureau staff, wrote a pamphlet for students' use entitled *You and the Wealth of the World.*

Study of Hammond Caused Changed Emphasis in Biology and Chemistry Courses

In Hammond, the chemistry teacher's study of the industries of the community led to considerable emphasis on the kinds of raw materials brought into the city, the industrial processes by which materials were fashioned into useful products, and the distribution of finished products to other communities. Local chemists gave advice regarding the skills and knowledge needed by technicians in the local industries. Some of these industries allowed students, in the second semester of their chemistry course, to work in their laboratories for a period of two weeks. The students were excused from their classes for this work and were given regular class credit for it. A number of students were thus given preparation in high school that made it possible for them to step immediately after graduation into industrial laboratory work.

Evening programs were arranged for both students and parents. Local photographers, metallurgists, nurses, chemists, and persons in related fields were speakers at these meetings.

Nearly every student carried out some project of interest to him. Some students demonstrated the chemical processes involved in local industries or made flow charts of materials through those industries; others made working models of various kinds; still others made charts showing the chemistry involved in the local filtration plant, the extraction of metals from their ores, the making of soap, the making of synthetic rubber, fractional distillation of oil, and other processes of importance in the great industrial plants in and near Gary and Hammond.

The school nurse in Hammond found an astonishing number of chronic illnesses, especially of older people, in the families of students. These illnesses exerted enormous tolls of time and energy from the whole family and contributed to absenteeism from both school and work. The finding that many students had responsibility at times for the care of relatives with chronic ill-

nesses led to added stress in the school on the subject of home nursing. The school nurse planned and taught home nursing in the biology class, not as a series of isolated lessons, but as practical applications of work in such units as diet, circulation, respiration, excretion, posture, and communicable diseases. These units are described in more detail on pages 66–67.

Study of Natural Resources Became Part of Biology Course in Glens Falls

In Glens Falls, the teacher's study of the geology, ecology, industrial history, and population of the region led to considerable modification of his course in biology for non-Regent students. Several weeks were devoted to the study of plant and animal communities, the factors necessary to successful community life, and the kinds of plant and animal communities that had developed or were developing in the Glens Falls region.

The study of communities was extended to include human communities, especially the city of Glens Falls. Students studied first the materials and sources of energy available in the region. Then they investigated the way these materials and energy were used to provide a living for the people. This procedure enabled the students to recognize and understand the flow of materials and energy through the community and its dependence upon the rest of the United States and the world. This unit is described on pages 93–94.

Relation between Land and People Was Center of Study for High-School Group in Greeley

In Greeley, the third-year program in the high school has for some years centered on study of the community and the relation between the land and the people. In that somewhat isolated and semiarid region the relationship with other regions stands out in bold relief. The dry climate and light rainfall of the area result in dependence on other regions for agricultural products; the presence of metals and minerals makes it a source of materials for

the industries of the world; the geography and geology affect road-making and transportation. All these factors form important topics for young people to study as a means of understanding the ways of living and the vocational and cultural opportunities in their community.[2]

Pamphlet on Cincinnati Was Prepared for Use of Students

In Cincinnati, the cooperating teacher prepared a pamphlet entitled *Our Town – Cincinnati.* It included a description of the population from the standpoint of racial origins, age, and health; the occupations and recreational opportunities in the area; and the development of the city over the years. Special attention was given to the Ohio River – its relation to the location of the city, the transportation facilities it affords, and the economic and human dangers entailed by its frequent floods. This pamphlet was used in both science and social studies classes along with motion pictures taken for the *Ohio River Survey.*

Community Study in Detroit Led to Development of a New Course

At Edwin Denby High School, study of the community disclosed increasing industrial concentration and a growing population in Detroit. These changes were causing problems of housing, of transportation, of education, and of relations among groups, especially between the whites and the rapidly expanding Negro population.

A committee of teachers from the science, social studies, mathematics, and home economics departments, together with a few interested students, decided that it would be profitable to establish an interdepartmental course focused directly on study of community problems. This course served as a center for group action across departmental lines. It is described in more detail on pages 57–60.

[2] Donald Decker. *The Relationship between Natural Resources and Activities of People in Colorado.* New York, 1943.

Indianapolis Study Led to Introduction of New Course

Sixteen teachers carried on the study of Indianapolis and eventually used the results as illustrative material in their classes. One teacher prepared pamphlets on community resources for student use.

The study established close working relations with many community agencies. In addition, an interdepartmental course in science and English, which drew heavily on the results of the community survey, was established. This course is outlined in more detail on pages 62–63.

CHAPTER 2. Study of Young People

When we focus attention on *learning* as opposed to a narrow concept of *teaching*, it becomes essential to know as much as possible about the children who are doing the learning, their backgrounds, their levels of maturity and ability, and their interests. Each teacher who cooperated in the Bureau project made a study of the class he was teaching in order to find out something about the individual differences represented in the class. In addition, most of the cooperating teachers had opportunity in the workshop of 1940 to learn from consultants some of the recent work on characteristics of young people in general.

Study of classes in the cooperating schools showed wide variation in intellectual development, cultural opportunities, and interests of students. Discovery of this variation obviously suggested better adaptation of reading material to the levels found in any one class. Vocational interests of students led, in many classes, to consideration of possible vocations and, in some places, to actual training in skills students would need in later life. Studies of students' interests indicated subjects for special projects and reports. Some students were found to need more contacts with life-situations in order to give meaning to their ready verbalizations; others with narrow interests and backgrounds needed help in seeing their everyday activities in the wider meaning of generalizations about life and its interrelationships.

It is interesting that only a few teachers gave consideration to the health problems of their students. One made a study of causes of absence; a few mentioned visual and nutritional defects. Many students came from homes in which exceptional health care was given; but undoubtedly, in many schools, study of

health records, defects, causes of absence, growth, and previous illnesses would have given useful information about the students and suggested valuable additions to the curriculum.

A number of schools reported that they considered their curricula well adapted to preparation for college but felt that other needs of students were not being met. In some schools, increasing numbers of students were not preparing to go to college. In others, most or all would continue their education beyond high school, but the teachers felt that more should be given to them in the way of general education. In all, there was dissatisfaction with the traditional emphasis on courses that prepared for later college work, and there was a desire to broaden curricula and experiences so as to give students greater understanding of community, personal, and world problems.

Studying about young people in general and making surveys of specific classes influenced the work of the cooperating teachers in two ways. They understood better some of the problems and interests of their students and adapted their teaching materials and methods to these problems and interests, no matter what the subject matter taught. In addition, many biology teachers incorporated in their courses new units devoted to study of human beings with the primary purpose of helping adolescents to understand themselves.

In general, it was felt that adolescents need to know something of the changes that are occurring in their bodies and in their emotional responses, should recognize some of the bases for family disagreement with adolescent desires, and should understand something of the conflicting social pressures to which they are exposed. Tenth-grade classes were most often interested in the physiological facts of maturing and in conflicts between parents and young people over the latter's privileges and responsibilities. Older adolescents were interested in problems of marriage and in other man-woman relationships. Reports of some of the curricular developments in the field of human growth and development are described in Chapter 6.

VARIATIONS AMONG SCHOOLS AND CLASSES

In many of the schools, individual classes were included in the Bureau project; in others, the cooperating teachers worked with several classes; in still others, as in Cleveland and Des Moines, all the science departments in the city were considered part of the cooperative project.

In general, students ranged in age from 12 to 20 years, although in any one class the age range was likely to be only two or three years. In Denby High School, about 7 percent of the population would probably attend college, in Cleveland 16 percent, in New Trier 75 percent, in Fieldston and Cranbrook almost 100 percent. In all the schools, however, certain classes were composed of college-preparatory students.

The average size of class was between 30 and 40 students, though the range was from 12 in an experimental class in Cranbrook to 50 or 60 in the classes of the Bronx High School of Science. In these two schools the classes were composed entirely of boys; all the other schools were coeducational.

In Cleveland, Des Moines, and Trenton, all the children of all the people were included in the high-school populations. In the three private schools, Lincoln, Fieldston, and Cranbrook, and in Oak Park and New Trier, the school populations were unusually homogeneous, being made up of students from homes above average financially and culturally. In other schools, as Arsenal Technical in Indianapolis, Olney in Philadelphia, and George Rogers Clark in Hammond, individual classes might be homogeneous as to family backgrounds and psychometric-test results, but the school population as a whole represented a wide variety of interests, abilities, and experiences.

Questionnaire Studies Influenced Many Parts of the Curriculum

In Arsenal Technical Schools in Indianapolis several questionnaires were given to students, the results of which were sum-

marized and distributed to members of the faculty. Some of these questionnaires related to interests in special fields, such as recreation. A more general type of questionnaire asked for such information as distance of home from school and method of transportation used in reaching school; whether home was owned or rented, whether it was a house or an apartment; whether the student lived with both parents, mother, father, or guardian; what student's major and minors were; whether student planned to go to college or to work after graduation; what occupation he hoped to engage in; whether he was employed outside of school, if so, where and for how many hours; number in family and how many employed; whether family had telephone and automobile; church affiliation, if any; favorite recreations; favorite magazines; favorite types of books; extracurricular activities and special lessons.

Indianapolis teachers also gave a number of questionnaires designed to find students' opinions in various fields. One was concerned with what students thought were important problems in their community. Another dealt with attitudes toward governmental planning of such community activities as location of factories, disposal of smoke, fireproofing of buildings, water supply, recreational facilities, and development of transportation. Another was designed to get some measure of students' attitudes toward various racial and national groups by finding how many boys and girls would be willing to play with, work with, or marry Negroes, American Indians, Germans, Irish, Japanese, and others.

Students were also asked to submit questions they thought should be answered in a high-school class in homemaking. The questions indicated that students were interested in learning about health care, the necessities of a simple home, marketing, inexpensive recreation, religion in marriage, sex relations and parenthood, desirable size of family, divorce, and living with in-laws. One group of chemistry students listed courses that had been helpful to them in preparation for life and others that

should have been included. They also formulated questions they thought school should help them solve concerning vocations, homes, finance, and college.

One of the most important results of these studies was more sympathetic understanding by the teachers of their students as human beings, with homes, families, financial problems, hobbies, church affiliations, and the hundred and one other personal characteristics that add richness to our contacts with other people, whether they be old or young. Student opinions on various problems showed gaps in their knowledge, which in many cases could be closed over by discussion or reading in connection with their courses. They showed, too, interests that teachers capitalized on in their teaching, through field trips and special reports. Many teachers took time, in and out of class, to discuss problems that were not specifically related to the subject matter of the courses taught but were disturbing to a number of students. An eleventh- and twelfth-grade class in physiology, following lines of interest shown by answers on one questionnaire, went from the study of heredity into discussions of choice of mate and marriage.

Questionnaires about Health Problems and Standards of Conduct Influenced Biology Classes

The school nurse at George Rogers Clark School in Hammond found, by questionnaire, students' ideas of care of illness. She discovered, for example, that students thought one could "cure" a cold by "wearing it out," taking aspirin, taking a good dose of whiskey, taking castor oil, or going to bed. Similar beliefs were found as to the cause and treatment of headaches and other minor ailments. These beliefs helped shape the teaching of the course in biology where stress was given to problems of home nursing (see pages 66–67).

Before the start of this project, the biology teacher had circulated a questionnaire through the entire senior high school as part of another study. Questions related in general to conduct of

young people: whether girls should smoke or drink; whether boys should smoke or drink; whether boys and girls should pet; what were the qualities desired in a wife or husband; whether parents should discuss with their children problems involving sex relations. At the end, space was left for questions that the students would like answered. This questionnaire and the students' answers were discussed with the parents at a Parent-Teacher Association meeting, and the cooperation of that organization was enlisted in planning a panel discussion before the senior high school. The panel included a mother, a father, the school nurse, a boy student, a girl student, a local physician who was also a member of the school board, and a consulting physician. A large number of parents attended the meeting.

The results of this program influenced the whole school and served to unite home, school, and community forces for an attack on some of the major problems of young people. In the biology classes, special attention continued to be given to the needs for information and for developing attitudes revealed by the questionnaire and discussions.[1]

Family Relationships Discussed

Adolescents are near the time when children normally leave their childhood homes and establish homes of their own; this aspect of development was reflected in questions in many classes.

In Denby and New Trier, discussions of children's responsibilities for their parents and of conflicts between parents and adolescents were held in tenth-grade classes in biology. Choice of mate and marriage were discussed at Arsenal Technical Schools. In Greeley, the college freshman class studied problems of marriage and man-woman relationships. Reports of these are included on pages 81–88.

[1] See *Suggestions for Teaching Selected Material from the Field of Sex Responsiveness, Mating, and Reproduction*, by Anita D. Laton and Edna W. Bailey, pp. 31–34. Bureau of Publications, Teachers College, Columbia University, New York, 1940.

Studies of Tenth-Grade Classes Showed Wide Differences and Resulted in Different Handling of Comparable Subject Matter

At Lincoln School study of the tenth-grade class took the form of a comparison of that class with the average in the United States as a whole. In general, Lincoln School students were younger than other children in the same grade elsewhere, but they had intelligence quotients decidedly higher, ranging from 108 to 160, with the average around 120. They had had excellent medical care and with few exceptions showed no uncorrected defects of eyes and teeth. There was some evidence of poor nutrition among the girls as a result of dieting.

The families of the Lincoln School students were small, although there were relatively few with only one child. The economic level was definitely superior; practically all the fathers were executive or professional men. Many of the mothers were employed, all in professional capacities. Hence, many mothers were not in the home during the day. On the other hand, most of the families employed full- or part-time servants. Most families lived in apartments or apartment hotels rather than in houses. Few homes had been broken by death but a fairly large number had been broken by divorce or separation.

The Lincoln School group enjoyed many cultural opportunities, had many books in their homes, went to theaters and concerts, traveled widely, listened to the radio, but seldom went to the movies. In general, their homes provided a full social life; in addition, the students engaged in engrossing school activities, belonged to special classes in music, dancing, and swimming, and spent their holidays in travel or at camps. There were few Negroes in the entire school and still fewer Asiatics. There was great stimulation in the homes and at school to an interest in world affairs, but this interest was verbal rather than experiential. In general, the students' acquaintance was limited to people of their own cultural and economic level and to servants. While

the students were interested in money, financial problems were related to luxuries rather than necessities.

Almost all members of the class planned to go to college and later to engage in business or professional careers. The girls would probably marry earlier than the boys if they followed the pattern of previous graduates. Pressure to make college-recommending marks was heavy on the boys; the girls spent much time on social engagements. Because of these pressures and because of the acceleration of the students, boy-girl relations were more strained than in many schools.

At Glens Falls, the children chosen for study were in a tenth-grade biology class of 28 students. None of the students was preparing to take Regents' examinations or to go to college. Chronological ages ranged from 15 to 20, the largest number of children being 15 years old. Intelligence quotients on an Otis test ranged from 72 to 113, the median being 84. Reading ages ranged from too low to be measured by the test to 21.3 years.

Two or three students with academic ability had been placed in this class because of program difficulties. Most of the boys, however, were taking shop courses; most of the girls, home economics and other nonacademic courses.

On a questionnaire, one boy said he was interested in automobiles, one in basketball, one in football. One girl belonged to Girls' Hi-Y. None of the other students listed special interests, although the school offered a wide variety of extracurricular activities.

Four boys worked outside of school, one in a drugstore, one with his father in a wood yard, two carrying papers. Three girls worked, two caring for children, one clerking in a grocery store.

Most of the students were tenth-grade students, although there were a few eleventh- and twelfth-graders included. The tenth-graders were at a disadvantage in extracurricular activities, because they were new in the school (a senior high school).

All students were of English, Irish, French, or Italian extraction. A foreign language was spoken in the homes of three.

The two tenth-grade classes described in the foregoing paragraphs obviously represent extremes of ability and background with corresponding need for widely differing learning opportunities. In Glens Falls, one problem was to supply interesting reading material at the students' level. In many cases, the teacher found that mimeographing simple statements of his own and making work sheets adapted to the vocabulary and experience of his students yielded better results than depending on textbooks and manuals. At Lincoln School, the students could profitably read at an adult level, far beyond that of ordinary tenth-grade textbooks.

In Glens Falls, the teacher could not count on stimulation from the homes or any general knowledge of literature and world affairs. At Lincoln School the teacher knew that current events were discussed at most of the dinner tables and that the students, in addition, had a wide acquaintance with the literary heritage of the race.

The Glens Falls students were already fitting into the vocational life of the community and would probably spend their lives there or in similar communities. Their acquaintance with productive activities was, and would continue to be, firsthand. The Lincoln School students were already, and would increasingly become, city-dwellers with firsthand acquaintance with the great cities of the world, their knowledge of production verbal, their experience with country life that of vacationists.

In Glens Falls, one problem of the teacher was to make the firsthand experiences of the students have more meaning, to give them knowledge that would be immediately useful, but at the same time to enrich their lives by giving them greater perspective than their participation in community and family life alone could give them. At Lincoln School, one problem was to provide students with the firsthand experiences that would give substance to their verbalizations and bring them into contact with the people and the ways of living on which our economic system and our urban civilization are built.

In both schools, the topics chosen for study were similar in that they included the interrelations of living things and changes through which individuals pass during their lifetimes. At Glens Falls, attention was given to the plant and animal communities in the environment and the factors essential to their survival; in Lincoln School, stress was laid on human communities and the relations to agricultural and mineral production that make a great city like New York possible. In a study of the human life span, one school stressed practical details of nutrition, abilities of children at various ages, and changes in behavior from age level to age level. In the other school, the class went further into fundamental physiological development and broadened its study to include sociological and philosophical implications of our knowledge of human development. Both of these courses are reported in more detail on pages 63–64, 72–78, and 93–94.

CHAPTER 3. Study of Current Problems

A well-recognized trend in modern education has been to bring into the classroom discussion of matters of vital concern to people as individuals and as members of families and communities. Forward-looking educators are not content to teach solely "out of a textbook" but measure their success by how well their students are able to meet and solve the problems that confront us all today.

From its beginning, the Bureau of Educational Research in Science was guided by the principle that teachers will teach better if, at their own adult level, they have grappled with the common problems of people living in our democracy, have become acquainted with the controversial issues for which present knowledge is not adequate, and have organized their own thinking and attitudes with respect to both what we know and what we do not know.

One aim of the Bureau was to prepare for adults materials concerning significant problems of today and the scientific facts and principles that are relevant for their solution. Specialists in science, social studies, and the humanities contributed facts and points of view from their fields of specialization to the thinking of the groups in the summer workshops. At each workshop, discussions, reading, and field work were centered on problems that the cooperating teachers thought most closely related to their needs and interests. The participants endeavored, first of all, to achieve as rich and as adequate an understanding as possible for themselves and, on the basis of this understanding, to plan materials and methods suitable to the varying levels of maturity and interest of their students.

LIFE SPAN

Consideration of the changes that occur in human beings as they live through their lives engaged the interest of all or part of the group over the three-year period. In 1940, consultants in the field of human development spent the summer at the workshop. They presented the concept of the human life span as an orienting and organizing framework for a mass of details about human beings, their changes from conception to death, and the significance of how they think and behave at one stage for thought and behavior at later stages. Special attention was given to the period of adolescence.

One result of the work on life span is mentioned in the description of how teachers became better acquainted with the needs and interests of their students (Chapter 2). In addition, some of the cooperating teachers made life span the subject of intensive study and organized teaching materials within it for their classes (Chapter 6).

INTERCULTURAL RELATIONS

Interest in the subject of intercultural relations had its beginning with a study of genetics in the workshop of 1939. Each summer thereafter consultants came to the workshop to present various aspects of the biological and cultural differences among people and the implications of these differences for current problems of racial and national intolerance. The presence in the 1943 workshop of both white and colored participants made this study more significant and more realistic.

A number of teachers planned and taught units of work adapted to the intercultural needs in their own communities. This was one of the fields of study in which it was obvious that adequate attack on the problems demanded cooperation among teachers of social studies and science. Administrative changes in schools were necessary for such cooperation (Chapter 5).

INTERRELATIONS OF LIVING THINGS

The interrelations of living things proved a profitable field for investigation through several years. *Life and Environment*, written by Paul B. Sears while he was on the staff of the Bureau, provided for many of the cooperating teachers a new approach to the problems of conservation.[1]

Study of communities of plants and animals with all their varied interrelations led to consideration of human communities and their interrelations. As part of the study of human communities, housing and community planning were stressed at two workshops.

All the teachers found that the work in this field colored their firsthand studies of the communities in which they were living and teaching. Several of the biology teachers incorporated material from this field in their courses (pages 18–22 and 90–95).

HEALTH

Study of health problems stemmed from the study of interrelations of living things and of the human life span. At every workshop, small groups spent time, first, in getting as complete an understanding as possible of the health problems and needs of young people; second, in investigating the resources that we have in knowledge and in social institutions for solving these problems. Some work in this field is discussed in the section on study of children (Chapter 2).

USE OF MATERIALS AND ENERGY

Man's use of materials and energy remained one of the most fruitful fields of study throughout the three years of the project. The starting point for thinking was *The Storehouse of Civiliza-*

[1] Paul B. Sears. *Life and Environment.* Bureau of Publications, Teachers College, Columbia University, New York, 1939.

tion, prepared in the Bureau by C. C. Furnas.[2] Dr. Furnas was a consultant in the 1939 and 1943 workshops, as well as a research associate during the first interval of the Bureau. His contribution to the cooperating teachers was to make them see more clearly that the progress of civilization depends upon our use of materials from the earth's crust and of energy from the sun. This idea involves both technological and sociological aspects.

The widely used phrases *economy of abundance* and *economy of scarcity* were given new and more adequate meanings in terms of the extent of the world's resources and the technological possibilities and limitations for making them available to human use. A number of the cooperating teachers endeavored to pass on to students this broadened perspective through work on fuels, minerals, electricity, and other materials and forms of energy (pages 95–109).

ECONOMIC TRENDS

Study of the foregoing topics in every case brought the group quickly and inevitably to consideration of our economic system and the problems of production, distribution, and wealth. Consultants came into the workshop each summer to answer questions in the field of economics and to discuss with the cooperating teachers what they, both as citizens living in a confused age and as teachers with specialization in science, should know.

Some of the material growing out of the discussions was incorporated in teaching units, especially in those interdepartmental courses where teachers from science and social studies worked together. The greatest significance of this work, however, was in the better orientation of the teachers themselves and in their understanding of how teaching about natural resources and human beings could be made to contribute to better community attack on the problems of food, shelter, clothing, health, and conservation of our material wealth.

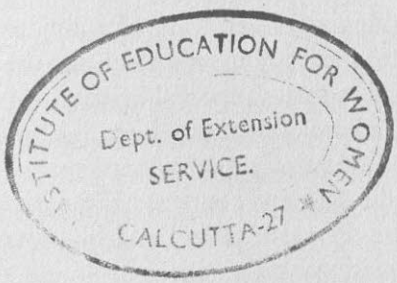
[2] C. C. Furnas. *The Storehouse of Civilization.* Bureau of Publications, Teachers College, Columbia University, New York, 1939.

MAN'S PLACE IN THE UNIVERSE

Changing concepts of time, space, and the structure of the universe are generally recognized as having important and sometimes disturbing effects on people's philosophies of life and general orientation. Several teachers, under the auspices of the Bureau, cooperated in an experimental study of this relationship (pages 110–116). Consultants in two of the workshops discussed with the participants some of the general relationships of science and religion and of science and ethics.

USEFULNESS OF SCIENCE AND SCIENTIFIC METHODS

The Bureau of Educational Research in Science was founded in the belief that scientific facts and methods have potential value for helping human beings to solve problems of personal and social life. All the consultants exemplified this belief in their workshop discussions and stressed not only the immediately useful materials in science but also the ideas which, if incorporated in people's thinking, would modify their behavior and improve their living. There was a continuous study by the cooperating teachers of scientific methods and how individuals can apply them in attacking matters of concern in their everyday lives.



SECTION II. Development of New Courses

CHAPTER 4. New Courses within Science Departments

Science teaching in high school is often criticized as taking place in traditional, subject-centered, college-preparatory courses, which are unrelated to the needs of young people in general and poorly adapted to the capacities of the vast majority of boys and girls. Whether this is more true for science than for the teaching of other subjects is irrelevant. Teachers in many of the cooperating schools felt that, however adequate their course offerings had been in the past, changing needs could best be met by new courses, which would spread beyond the limits of the traditionally organized fields of chemistry, physics, zoology, and botany.

With one exception, the new courses were planned for students who were completing their formal education in high school. They were designed to show these students how to use pertinent scientific facts and principles in dealing with problems of immediate concern. Problems, rather than traditional organizations, determined the content.

From the standpoint of selection of subject matter, much of the material in the new courses could also be found in older courses. In new courses in physical science, however, the focus of interest was on answering students' questions and making practical applications to a greater extent than in physics and chemistry. In new biology courses stress was placed on maintaining health, conservation of soil and biological resources, and understanding relationships among people.

One school set up a two-year course intended to include the scientific ideas important to the ordinary citizen. In this course,

even the dividing lines between biological and physical sciences were ignored when the division was irrelevant to the problems at hand. The purpose of the course was the development of new "minimum essentials" in the context of modern living.

In method, the new science courses included more nonverbal activities than do the older courses. Since the aim is individual use of the materials learned, stress is put on individual and small-group work.

These new courses originated in at least three lines of thought: (1) Since problems cut across subject-matter lines, so also must the solution of them. People need to be able to use in their thinking facts and principles drawn from many fields; they will use these best if they learn them in relation to common problems. (2) In the past American high schools were populated by a small group with restricted academic interests. Now there are in high school many more young people from all types of homes, with all kinds of interests. There is a certain exigency in planning education for these students who will soon be directing their own lives and those of others. Courses developed as preparation for college are often misfits for students who may not even finish high school. (3) Work with this group of students is as yet undominated by tradition. It offers opportunity for experimentation with content and method. The results of these experiments may, in turn, influence the older courses and the whole curriculum.

An experimental chemistry course for college-preparatory students was the exception to the general rule that new courses were designed for nonacademic students. In this course, stress was put on independent work. Results were evaluated not only in terms of students' performance in chemistry but also in terms of improved methods of learning as the students applied them in courses other than chemistry.

The greatest improvement in the experimental chemistry course was shown by the students with the highest intelligence quotients. This suggests that, while it is important to make ade-

quate provision for students who have little academic ability, it is also important to continue to modify courses so as to capitalize on the special abilities of our other young people. They are able to learn more scientific facts and principles than their fellows. Probably, they can also learn early the methods of investigation that will enable some of them to enter the fields of fundamental research and to take leadership in applying the results of research to betterment of the general welfare.

DESCRIPTIONS OF NEW COURSES

Biology (New Trier High School)

The faculty at New Trier High School felt in 1940 that they had succeeded in developing courses which were well organized, well taught, and filled a definite need—namely, college preparation—of a large proportion of the student body. The faculty felt, however, that another portion of the student body was not being adequately served. This portion was composed of the students who had fewer academic interests than the other group and were not preparing to enter college.

Tenth-grade students of the noncollege-preparatory group were placed in special classes in biology. The teachers who were assigned to develop the new course in biology began by studying their prospective students. They made an analysis of personnel records in order to understand their students' family backgrounds and the students' interests, intelligence, achievement, health, and aptitudes. In this study the unusually fine records that are kept of students at New Trier were very helpful. In terms of this knowledge of the students, the teachers planned a year's program in biology "designed to include only material that the students could apply in understanding and facilitating their own development, in developing their own philosophies, or in understanding the society in which they live and its problems."

As the course developed, student participation became an essential part of it. In general, work was carried out through com-

mittees, who functioned more or less independently and gave reports and demonstrations to the class as a whole. Observers were impressed by the seriousness with which these committees of students took the responsibility of educating their fellows. The committees thought that their work was important and tried to show this to others. The tempo was slow; the teachers were constantly alert to ask questions and make comments when needed. The result was careful, individual thinking at a level not often found even in classes made up of very bright students.

Following is the outline for this course and a few comments that were made at the end of the first year.

I. Introduction
   A. What the students expect of New Trier; what they expect from this biology course
   B. Planning
II. Health, a personal and social problem
   A. Body defense and immunity
   B. Germs and germ diseases
   C. Diet and deficiency diseases
   D. Gland disorders
   E. Degenerative diseases
   F. Nervous disorders
   G. Inherited and accidental defects and allergies
   H. Drugs
   I. Public health
   J. Modern developments in medicine, surgery, etc.

COMMENTS: "Unit II was satisfactory, except that (1) it took too long; (2) there were not enough activities of the nonverbal nature." At the workshop the following year one of the teachers from New Trier High School collected suggestions for nonverbal activities, such as experiments, movies, trips, microscopic work, laboratory demonstrations, making of cultures, testing milk and water, feeding laboratory animals, and making charts and diagrams.

III. Conservation of natural resources
- A. Soil: types, destruction
- B. Water: flood control, irrigation, water power, stream pollution
- C. Mineral resources
- D. Fuel resources: coal, oil
- E. Forests
- F. Wildlife
- G. Planning wise use of resources

COMMENTS: "Unit III was not entirely successful, partly because of the methods used, partly because students felt fed up on conservation. A new approach through study of the local community, the metropolitan area, the state, and the region might be effective."

IV. Sex, reproduction, and family life
- A. Background material: reproduction in lower animals to learn terminology and methods of reproduction and to accustom the class to discussion of the subject in unemotional terms
- B. Human reproduction
- C. The family: family patterns in other societies and other times; the biological and economic bases of the family; economic changes and their effect on family life; the family in modern society; boy-girl relations (very briefly); causes of friction between high-school students and their parents

COMMENTS: "Unit IV was enthusiastically received. The majority of the students indicated that they thought it was the most important one they had studied. Lack of materials for the students hampered the teacher considerably."

V. Heredity and its application to some social and personal problems
- A. Physical basis of heredity
- B. Improvement of domestic plants and animals

C. Eugenics: heredity *vs.* environment
D. The "race" problem
E. Evolution

COMMENTS: "Unit V was rather successful. The questions on race, evolution, and, to some extent, eugenics seemed to be very stimulating to most students. More nonverbal activities should be developed."

Biology (Arsenal Technical Schools)

A course in biology, sponsored by the departments of zoology and botany at Arsenal Technical Schools, was developed experimentally in 1940–1941. Students desiring to take a course in biological science were placed in biology if they had averaged C or below in the last semester of English. Otherwise, they were assigned to botany or zoology, according to their interests.

The chairman of the biology committee stated the problem thus: "This segregation makes stronger botany and zoology classes but, at the same time, increases the task of the teacher. In order to make a satisfactory degree of success with this group, it is necessary to have careful diagnosis of each student and use special methods adapted to each individual."

Because this course was experimental, it was evaluated at intervals by the teachers, heads of departments, and teachers of other subjects. One teacher of biology was outstandingly successful in the use of projects developed by individuals or small groups of students. In all the classes it was felt that students profited by the segregation in that the work could be adapted to their needs and interests. On the other hand, some teachers felt at the end of the first year that segregation according to ability was unsatisfactory, because (1) it brought about class distinctions of which students were conscious, and (2) it deprived some students of class association with other students whose good habits, proper attitudes, and ideals might have given them encouragement.

The content of the biology course was made up chiefly of

material on health, conservation of resources, and recreation. Conservation of forests, soil, and other resources was studied in terms of their contributions to food supply, high standards of living, and avocational satisfactions. Emphases were on (1) food and health habits to build strong bodies, for peace, war, and other emergencies, (2) world-problems of distribution, and (3) Indiana's contributions from its biological resources to the war effort. An extensive visual program was developed. The Nature Preserve on the campus of Arsenal Technical Schools gave opportunity for firsthand study of plants and animals to their natural habitats. During the war, biology students helped to develop demonstration Victory gardens on the campus.

One problem among biology students was the large number of absences and withdrawals. Although recognized as characteristic of students with low scholastic records, it was a cause of disappointment to the teachers.

At the end of three years it seemed proved beyond a doubt that the biology course had a definite place in the science curriculum. Some teachers even questioned the desirability of offering it to the slower students only. However, it was true that the botany and zoology classes now contained only those students who were definitely interested in, and able to cope with, those subjects on a college-preparatory level.

Physical Science (New Trier High School)

After the biology course was fairly well established at New Trier High School, a teacher was asked to develop a course in physical science for the same noncollege-preparatory group. Students were those who elected chemistry and physics but showed by their marks in previous courses, their records on intelligence tests, and their rank in their class that they were probably unable to carry successfully and with satisfaction to themselves the usual work in chemistry and physics.

The course met school requirements for graduation but could be used for college entrance only as an elective. Eighteen stu-

dents elected the course. In general, they rated below the average for the school, although their IQs ranged from 88 to 123. They lacked initiative and ability for long-range planning. It was hoped that, from the work in physical science, they might develop more responsibility, cooperation, and critical thinking as well as appreciation of science in modern living and understanding of some consumer problems.

Student participation was stressed in this course, as it was in the biology course. Even more effort than in biology was made to encourage students to assist in planning. Plans were discussed by the whole class: then interested members chose special phases of the subject under investigation for further study.

No one textbook was used. Instead, many textbooks, reference books, periodicals, and bulletins were consulted as needed. Students were more interested in individual laboratory work than in other activities. Committee reports were often accompanied by demonstrations or class laboratory work.

The topics investigated included nature of matter, chemical and physical changes, housing, and fuels. The class participated in the following activities.

Films: on such subjects as sulfur, plastics, steel, paint, sound, light, induction, the electric motor, the gas motor, water power, the atmosphere, gas pressure

Field trips: to the Museum of Science and Industry, high-school heating and ventilating plant, school radio and audition studio, radio laboratory. (Other trips were planned but because of wartime restrictions could not be carried out)

Projects: making of oil maps, road maps, and flow charts of coal, oil, and electricity; sketching floor plan of a home; analyzing fuel and light bills; mapping government dams and irrigation districts

Discussions: of articles in each issue of *Consumer's Research;* on war gases by an expert in the field

The students maintained a high level of interest throughout the year; several even elected further courses in chemistry and physics. On tests they showed improvement in fundamental scientific skills and in understanding of community problems involving use of resources. Because of wartime changes in the faculty, the course had to be discontinued, it was hoped only temporarily.

Physical Science (Arsenal Technical Schools)

The physics and chemistry departments of Arsenal Technical Schools joined forces in developing an experimental science course designed to meet the needs of vocational students with below-average achievement in mathematics. Effort was made to adapt both content and methods of teaching to the students in the classes.

The principles underlying our knowledge in the physical sciences were presented in such a way as to show their applications in everyday life and in industrial procedures. Laboratory exercises were designed to be simple and practical. Work sheets contained specific questions and references. The teachers prepared the work sheets as needed, thus maintaining flexibility in planning. No one textbook was used at first; later some of the classes used a basal textbook.

This physical-science course has been under constant revision in an effort to make it better meet the needs of students, especially those whose primary interest is shopwork. As a result of placing these students in special classes, the regular chemistry and physics classes have been strengthened as college-preparatory courses.

Physical Science (Oak Park-River Forest High School)

In the year 1941–1942 the faculty of Oak Park-River Forest Township High School made a study of their school and community and formulated their philosophy of education. This statement of philosophy may be summarized as follows.

1) Secondary education should be provided at public expense for all normal youth in the community.

2) In a modern high school there should be equality, not identity, of opportunity.

3) Every normal and industrious student should have a chance to succeed in tasks that challenge him and are within his ability to achieve.

The staff of Oak Park High School, as of the other cooperating schools, felt that one of its problems was to make better provision in the curriculum for students of below-average ability. In 1942 plans were made for a series of courses on an experimental basis.

One course in practical chemistry was designed for boys in the eleventh grade who had IQs below 105, an average of C or poorer in algebra and geometry, and mechanical rather than academic interests. This class, obviously, was not below average for the country at large, but it did represent a group for whom the curriculum at Oak Park was not suited. The course was built around problems of practical importance, such as those relating to fuels and storage batteries. It was recognized that developing such a course demanded time. Consequently, the teacher was freed for one period through the first year to work out a syllabus.

Integrated Course in Biological and Physical Sciences (Central High School)

For some years preceding 1940 Central High School had offered courses at two levels in biology, chemistry, and physics —one for students planning to enter college, the other paralleling the college-preparatory course but at a lower level of difficulty. In 1941, the problem of the department was stated as follows.

"Although our upper-level science courses have prepared students adequately for college entrance, neither our upper- nor our lower-level courses have prepared them adequately for life, even in areas where science should have been effective. Information

acquired as a duty was forgotten without sense of loss and without leaving any considerable residue of desirable attitudes, appreciations, or changes in behavior, either in school or in community life. We tried to make our lower-level courses more practical by change of emphasis; we used new textbooks; we eliminated many technical terms; but it did not seem to make much difference.

"We do not mean to imply that our situation has been worse than that in other schools; and many worth-while objectives have been attained in varying degrees, in spite of the handicap of stereotyped subject matter. Probably most people would say that we have done a better-than-average job, but we are not satisfied, and we believe that improvement is possible."

The attempt at a solution was summarized: "We finally decided to break away entirely from the requirements or traditions associated with our lower-level courses in biology, physics, and chemistry and to build a two-year science course based on what we know of students' needs, present and future, and what we have in the field of science that we think will help. The new courses, while radically different in principle, are not revolutionary—for two reasons.

1) Not all that has been done in the past is valueless, and we hope to retain what is good.

2) Teachers, like other people, tend to do as they have done and to favor the organization that was taught to them.

"The difference is that we are *not* limiting ourselves to one science subject at a time, nor are we attempting to follow the logical sequence or organization that may be found in specialized science courses. We *are* attempting to help the students use information and methods from anywhere in the field of science as a means of solving, or at least attacking, the problems that arise in daily life. The idea is to *start* with the problems and then draw on whatever there is in the field of science that seems appropri-

ate. Working from this point of view, a two-year course in the sciences was developed around the following outline.

SCIENCE I

Science in the school environment
Science in the home (consumer science)
Health in the home and in the community (communicable disease)
How the healthy human body functions
Plants and their importance to man, including study of growth, reproduction, heredity, soils, ecology, and conservation

SCIENCE II

Natural resources (materials and energy) and how they are utilized
Weather and climate
Stars and planets
Machines: how they work, what they do, and their effect on man
Trenton industries
Growth, reproduction, and improvement of living things

"It will be noted that Science I draws more heavily on the field of biology, and Science II on physical science; one reason is that the enrollment in Science I is likely to be larger than in Science II, and we feel that material on health and other personal and home problems should reach the largest possible group."

The details of the course have been modified in the years since it was instituted, but the main outline remains about the same. The department has seen no reason to change the fundamental principles which guided it in the development of the course. Flexibility is allowed individual teachers and individual classes in determining emphases and in choice of reading, trips, visual aids, and other learning aids. In a recent article the head of the de-

partment sums up his attitude: "We never do as well as we would like, but we never give up hoping, and planning, and trying to do better."[1]

Experimental Chemistry (Susan Miller Dorsey High School)

Five experimental classes in chemistry were conducted in Susan Miller Dorsey High School in 1940–1942. The emphasis was on problems and on the development of ability to attack problems independently. Scientific journals, government bulletins, community publications, textbooks, advertisements, and popular periodicals were sources of information. Experiments were planned cooperatively by students and teacher when need arose for information best obtained through experimentation. All of one teacher's time was devoted to these classes.

The first weeks were devoted to orientation. The classes made some study of the community and decided on general problems to be worked on during the first semester. Agriculture, petroleum reserves, and water supply are examples of problems thought important for southern California by several classes. As the war forced changes in ways of living and thinking, nutrition and "critical" metals were recognized as urgent problems. Problems for individual student research were decided on during this exploratory period.

Through the first semester, work consisted of class reading, discussions, experiments, and trips related to the general problems, and some individual work on special problems. Work on the individual problems was reported to the class from time to time. At the end of the semester, written reports with complete bibliographies were filed with the teacher, together with models, charts, or other materials that had been collected or constructed by the students. All of these were available to later classes.

During the second semester more emphasis was placed on in-

[1] J. G. Manzer. "Present and Future Science Courses," *Science Education*, April-May, 1945, pp. 143–144.

dividual problems. Sometimes a student selected a problem in quite a different field from that of his first choice. More often he chose a limited aspect of his problem of the first semester. For example, one student spent a semester on the general topic "Metals in Industry" and in the second narrowed his interest to "Nonferrous Alloys in Aeronautics"; another moved from "Chemistry in Art" to "The Chemistry of Restoration of Paintings."

Such a radical departure from traditional techniques must be carefully evaluated if it is to be useful to others. As part of such evaluation, a careful study was made of 230 matched pairs of students. One of each pair was a student once enrolled in a section of the experimental chemistry program; the other was a student of the same IQ from another type of chemistry course offered in the school. There was convincing evidence of a kind of transfer. The students from the experimental course gained higher grades in other courses than students of equal ability who had not taken the experimental course. It is interesting to note that students with higher IQs profited most from the experimental course.

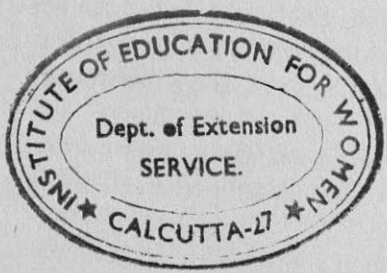
Results on standardized chemistry tests showed that students in the experimental classes gained adequate factual knowledge of technical chemistry. Grade-point averages after one year in college showed a slight over-all advantage in favor of the experimental group.

A special testing program within the classes themselves showed improvement of students' ideas of the interrelationship between themselves and the environment, increase in desirable social attitudes, increased ability to organize material and to give oral and written reports, and development of library and laboratory techniques. The teacher added as one value of the course the opportunity for growth given the teacher.

The program has been of interest to instructors in a nearby university where an experimental class coordinated with this program was developed.

Difficulties ensuing from this type of approach include amount

of teacher time demanded; lack of easily available printed material; inadequacy of laboratory equipment and space; and students' failure to master chemical calculations to the point where they can compete on equal terms with students from other classes when mathematical problems are the center of interest (as in certain tests).



CHAPTER 5. New Interdepartmental Courses

As the cooperating teachers turned their minds toward the real problems of human beings, they became more and more aware of the impossibility of thinking and teaching within the neat compartments of traditional courses. Real problems and the solution of them cut across subject-matter lines. There seems general agreement that compartmentalism and isolationism are as outmoded in the classroom as they are in the world at large. Specialists in the field of science must link their knowledge with that of specialists in other fields, if schools are to help children develop an integrated and comprehensive understanding of the problems of everyday living.

To implement this ideal, interdepartmental courses were worked out in several of the cooperating schools. No two of the courses were alike; each was adapted to the community, the students, and the administrative setup of the school involved. Some interdepartmental courses had been initiated before 1940 when cooperation with the Bureau started; others were the direct result of the cooperation; all showed interesting developments through the years 1940–1943.

These interdepartmental courses showed wide variation in administration, ranging from complete reorganization of all subjects in the curriculum to informal correlation between two traditional subjects. A few of the courses were planned cooperatively by teachers of several subjects; in most cases the courses were planned and taught by teachers of science and social studies or teachers of science and English. In general, the most permanent seem to be those in schools where reorganization involved all subjects of the curriculum. Such complete reorganization took place in schools in which the interest and backing of the adminis-

trative officers were wholehearted and thorough. However, in the case of the courses that did not survive, the war must be considered as a powerfully disrupting factor.

The most important conclusion to be drawn from the work in schools where interdepartmental courses were instituted is the necessity for providing time and opportunity for teachers to plan and work together. This conferring is so essential that it cannot be relegated to odd moments snatched now and then from so-called "free" periods but must be an integral part, somehow, some place, in the teachers' programs. Related to this is the necessity for knitting correlated and integrated courses into the total school schedule. For a time perhaps, until the experimental stage is past, they may need special consideration. Certainly in teacher assignment, in time allotment, in student programming, they must be given the same kind of consideration as other and more traditional parts of the curriculum. Both of these requirements can be met only by flexibility in administration.

DESCRIPTIONS OF COURSES

Integration of All Subjects in Ninth Grade (Bronx High School of Science)

The principal and staff, in 1939 at the end of the school's first year, selected a committee to develop some form of integrated program for attaining the aims of general education. The committee was drawn from the departments of English, social studies, science, art, mathematics, and music. An integrated program of work for the ninth grade was planned. Through two years the integrated program was taught in experimental classes, while the usual subject-matter courses were taught as controls. In 1941 the advantages of the experimental program seemed to outweigh the disadvantages, and the integrated program was spread to include all classes in the ninth grade. Since then changes have been made, some rather drastic, but the fundamental pattern remains the same.

Basically, the pattern consists in all classes studying the same problem at the same time. For example, if the topic is "Health," the social-studies classes consider such subtopics as costs of ill health to the individual and to society; changes through the ages of our ideas of health and disease; New York's protection of health through water purification, waste disposal, and curbing of smoke and noise; the work of the United States Public Health Service and other governmental agencies; safety hazards; modern treatment of mental diseases; socialized medicine; and applications of our knowledge of health to problems within the school itself. Of recent years increasing attention has been paid to problems of health on an international scale. The science classes at the same time study the spread of communicable diseases, the developments in medicine with emphasis on the contributions of such men as Koch and Pasteur, modern methods of transportation as factors in spread of disease, the correction of popular superstitions and errors, and current scientific developments. In English, readings about the lives and work of men in the field of health are assigned. The students take notes and read to gain precise ideas. Current developments in the field and writing designed to make these easily understood may also be included.

The topics chosen for study have varied somewhat from year to year. The first two units following the opening of school have been related to the problems of the children themselves. Two weeks or so are spent on "Orientation": learning the attendance routines and other rules of the school and considering such problems as making friends in a new situation and finding a place in school clubs. This orientation process slips imperceptibly into a unit on "Personal Problems." Here the social-studies classes study the varied resources of the city to see how they may contribute to rich personal living; science classes present material on "How We Learn." All classes stress the formation of study habits, use of the library and other school resources, and budgeting time so as to provide for a well-balanced day and week for stu-

dents of the ninth-grade level. Mathematics classes contribute by showing the meaning of *average* and deviations from the average, as background for understanding the significance or insignificance of being unusually tall or short, or differing in other ways from one's fellows.

The remaining units are more academic. One has been "The Individual and the Community in Time of War." Another has been "We Fight a Global War" with such subunits as food, shelter, and housing considered in their national and international relationships. Now undoubtedly the same basic material is being studied in its relationships to problems of the peace.

This curricular reorganization has been carried out largely within the framework of departmentalization. The students move from class to class at the sound of a bell as in most secondary schools. The social-studies teacher takes up each day where he left off the day before rather than where the English teacher or the science teacher of the previous hour left off.

To supplement this program, one day each week is devoted to student-centered activities which cut across several class periods. Trips are taken, programs are given, newspapers are edited, and various social activities are carried out.

At the end of each semester what the school calls "integrated" examinations are given, in addition to any subject-matter examinations the teachers think desirable. In these examinations students are asked to draw on their experiences in any or all of their classes in order to answer questions or carry out directions. In one examination, for example, they were asked to write a small pamphlet designed to tell young refugees about adjusting to life in America. In another, questions were on plans for organizing a camp on an abandoned farm acquired by the school. Another related to a housing project and drew on the students' understanding of good and poor housing, health and safety factors, economics of housing, and various aspects of governmental participation in provision of houses.

Whenever a new curricular organization is attempted the

question always arises "But do the students learn as much?" The early work with control and experimental classes has enabled the Bronx High School of Science to answer this objectively. At the end of two years, a specialist in evaluation gave a battery of eleven tests to the two groups of students. There was no evidence of difference between them so far as mastery of subject matter was concerned. The experimental group made higher scores on attitude tests and on tests of skill in use of scientific methods. The teachers' subjective judgment was that students in the experimental classes gained in ability to see each problem as a whole, in social cooperativeness, and in individual responsibility for group achievement and discipline. Incidentally, the teachers felt that they themselves had gained in awareness of social problems and in ability to deal with them.

The success of the experiment in this school, as in all the other cooperating schools, was made possible only by careful planning. In the early stages interested teachers gave many hours of their time to conferences and organization of ideas. All felt, however, that they were richly repaid in personal stimulation and interest. Later, when all the teachers of the ninth grade were involved, a workshop was arranged for the week before the opening of school. During the workshop, plans for the year were made. Thereafter weekly conferences sufficed to fill in details. The student-centered activities on one day of each week made it possible for groups of teachers to hold conferences during the school day, while other teachers took responsibility for larger groups of students. The consensus was definitely that any plan for curricular reorganization must include plans for teacher conferences.

Integration of Science and Social Studies
(Edwin Denby High School)

By the end of the 1930's a number of teachers in Denby High School felt that social pressures were mounting dangerously in Detroit and the surrounding region and that they presented a

challenge to education. Throughout the year 1940–1941, a committee of teachers from several departments (English, social studies, science, mathematics, and home economics) held a series of conferences and decided that a new course would be desirable, one that was focused directly on study of community problems. A tentative plan was drawn up, and two teachers, one from science and one from social studies, were chosen to organize and teach the course. These two teachers did preliminary planning during the spring and worked intensively at a Bureau workshop in New York in the summer. This preparatory planning and orientation of the teachers was deemed essential here, as it was in the Bronx High School of Science in New York.

The Denby High School teachers felt that citizens in a democracy need definite preparation for solving problems in ways suitable to a democracy. They listed three fundamental needs.

1) Development of a long-range social viewpoint based on scientific principles

2) Development of a desire to do something about social problems

3) Development of ability to work cooperatively on the analysis and solution of problems

Educationally, these needs implied emphasis on methods of learning as well as on subject matter.

It was decided to center the work about three topics: housing, racial and national group problems, and social hazards. In line with the fundamental viewpoint of the sponsoring committee, the teachers worked, first of all, to make themselves as competent as possible in the fields related to these problems. They collected a wide variety of materials for use in the classroom but left the details of exactly what a class would study to be settled by students and teachers working together through the semester. Trips into the community and conferences with persons outside the

school were to be stressed as means of firsthand acquaintance with community affairs.

The administrative arrangements for this class are of special interest. The students received credit in social studies and in science. They met for two consecutive periods daily. Each teacher was assigned to one class period, but in practically all cases both teachers were present through both periods. As everyone knows, one reason for the narrow departmentalization of high-school curricula is the specialized preparation of teachers and their inability to exert authoritative and competent leadership outside their own fields. Having two teachers present in these classes made it possible for both to contribute, at any time, relevant material from their specialized backgrounds. This administrative arrangement solved one problem but introduced another, that of increased teacher load. Theoretically, it is possible to meet this latter difficulty by putting two classes together and assigning them to two teachers for two hours. The war and reassignment of teachers interfered with further developments at Denby—but only temporarily it is hoped. Perhaps other interested administrators will work out the details of programming such classes.

At the beginning of this project the lines between social studies and science were fairly closely drawn. As time went on, the approach became more and more unified, with both teachers able to move freely in both fields. The topic on housing included, from the standpoint of the individual, house-planning, methods of building, use of new materials in homes, and principles of neighborhood planning. From the standpoint of the public, the class studied, often at firsthand, obsolescence of housing in Detroit and the problems of regional planning.

The unit on racial and national group problems included study of heredity and environment, of eugenics and euthenics as possible programs for human betterment, of group conflicts now and in the past, of educational and other inequalities in the

United States, and of the meaning of democracy. Under the unit on social hazards came such topics as life and health insurance, social-security programs, public health, socialized medicine, government control of prices and wages, and problems in a postwar world. Attempt was made to find and study the real problems of Detroit instead of side-stepping them, as too often happens in schools.

Evaluation of this course was made by students, teachers, and a committee that was making a larger study of the educational opportunities at Denby High School. All felt that the course should be continued, but that special effort should be made to solve the problem of excessive time demands on teachers. Some teachers and some students expressed fear that student participation in planning constituted an uneconomical use of time. However, most felt that such participation constituted essential practice for citizens of a democracy and must be judged in terms of the fundamental objectives of education.

The students made real gains in knowledge, as shown by subject-matter tests given by the teachers. Work was adapted to individual abilities and interests, and every effort was made to spur students on to greater independence and initiative. Tests showed that they learned to approach problems open-mindedly and to think of other people more tolerantly. In the long run, such achievements may well prove of greater importance than "covering" more ground.

Integration of American History and Chemistry (Olney High School)

In Olney High School an interesting attempt was made to integrate material from science and social studies while preserving intact the curricular pattern of the school.

One of the science teachers made a study of Philadelphia and the region of which it is a part at a Bureau workshop and came to the conclusion that high-school students would profit by the same kind of study. Other teachers in the school were interested,

and it was decided to introduce material about the city and region into the courses in American history and chemistry, since these two courses are taken by most eleventh-grade students in the academic curriculum. The same group of students was scheduled for adjacent periods in these two subjects. The two teachers considered their courses of study carefully to see where information and activities related to Philadelphia could profitably be introduced, either independently or in such joint enterprises as trips and special reports.

One of the aims of the project was to reduce the barriers that exist in the minds of too many students between what they learn in one class and what they learn in another about the same problem. Common ground between the history course and chemistry course lay chiefly in study of the industries of the city and region. Fuels and minerals and the processes involved in their use were studied in direct relationship to the influence that the industries using them had had on the development of the city. The flow of raw materials into the city and of finished products away to the rest of the world was an organizing concept which tied together a multitude of chemical and historical details. Provision of utilities and disposal of wastes were also appropriate subjects for study in both classes. The study of Philadelphia's water supply ramified widely into consideration of the waterways as a factor in the location of the city and into study of the agencies and processes involved in maintaining a safe and adequate supply of water for personal and industrial uses.

Once started, there seemed almost no end to the possibilities of integration or correlation between these two subjects aimed toward better understanding of the community. Unfortunately, program difficulties and shifting to wartime emphasis interrupted this project before it could be fairly evaluated. One of the teachers involved had to be replaced; some of the students participating during one semester could not be scheduled for these classes during the second semester; and new students came in who were not taking both courses.

Integration of Science and English
(Arsenal Technical Schools)

In Arsenal Technical Schools, as in Olney and Denby schools, the integrated course was built around study of the community. The correlation was between science and English and was intended for tenth-grade students who elected both subjects. The class met for three periods daily, with the science teacher present the entire time and the English teacher for two periods.

This course grew out of the community study carried on for two years by a committee of teachers (pages 16 and 22). The existence of this committee and its months of work meant that the faculty of the school was well informed as to its findings and was in sympathy with the course that was so definitely an outgrowth of its work. The reports of the committee provided a wealth of material for class use.

Plans for the course began with the selection of a list of twelve topics. Problems of the immediate community related to each of these topics and activities from the fields of biology and English which would enable students better to understand these aspects of their community were listed. In study of food, for example, sources and distribution of food, agriculture in Indiana, and diets of the city's inhabitants represented significant problems for Indianapolis. Field trips to farms, markets, and food-preparation laboratories were planned to give students firsthand acquaintance with some of these problems. Study of soils, plants and photosynthesis, food essentials, nutritional processes in animals and plants, and the elements of good diets provided activities from the field of science. English activities included making special reports on food fads and food habits in America and elsewhere, reading pamphlets and articles in current newspapers and magazines on food and rationing, taking notes on a talk by a dietitian, and reading DeKruif's *Hunger Fighters*. Other units were similarly planned.

This experiment provides one answer to the oft-repeated ques-

tion "How can English teachers give assistance on the written and oral reports made in other classes?" When both English and science are being studied in relation to a common theme—in this case, understanding of the community—the same standards are held for *all* reports and notebooks. The administrative setup of having two teachers in the room is, of course, expensive in teacher time and is possible only during an experimental period.

Core Course on Human Living (Lincoln School)

For some years previous to 1940 Lincoln School had been developing courses based upon broad areas of interest. These courses came to be designated as *core courses*. Most of these had centered in the social studies. In 1941 it was decided to try out in the tenth grade a core course devoted to problems of human living and taught by a teacher of science and a teacher of literature. The emphasis was to be on helping boys and girls to understand their own growth and development in various and significant social relationships. Original plans called for study of the individual, of the family, and of the community. In practice, however, almost all the time was devoted to study of the individual and of the family (see pages 72–75).

The work in this class was conducted very informally, at times one teacher being the leader, at other times the other teacher. The teacher of literature insisted that he merely sat in the classroom and participated casually until the opportunity arose to "bring in" some English. This statement perhaps describes the informal atmosphere prevailing in the class; it does not, of course, do justice to the thinking and conferring of the two teachers or to the alertness and interest of both in seeing how study of human beings extends into the fields of their specialization.

An example may give a clearer idea of the class than much description. Work started under the leadership of the science teacher in a panel discussion of the differences among human beings. One difference brought out was that of stage of development, and the class listed stages in human development: prenatal

life, babyhood, and so on to old age. The literature teacher contributed Shakespeare's statement on the ages of man, and this led to some reading and discussion of *As You Like It*. The students decided that Shakespeare's listing of the life-stages was accurate but incomplete. They thought it especially "unfair to women." They then attempted to write descriptions of the stages in a woman's life and, through this writing, were introduced to problems of scansion and blank verse. In other words, the scientific discussion of human development was integrally tied to activities usually included in classes in literature and composition.

Throughout the course, innumerable facts from physiology, anatomy, embryology, psychology, genetics, and other science fields were brought to bear on students' understanding of themselves, their families, and their relations to other people. The students did some work in the laboratory, chiefly physiological and psychological; they studied children in nursery schools and hospitals; they saw a number of movies; they read a wide variety of books and articles; they did a great deal of writing of both the formal and creative types. In many cases they reworked scientific ideas imaginatively, sometimes humorously, in prose and poetry.

The most important activity of the year, and the one that required most time, was the writing of autobiographies. For these, the students collected data about their own development from their families and from records. Then they compared their own development with what has been found true through scientific studies of children in general. The science teacher stressed reliability and objectivity in these reports; the literature teacher stressed interest and readability (see pages 72–75).

Integration of Chemistry and Economics
(Cranbrook School)

A chief objective at Cranbrook is to lead the boys in the school to understand and appreciate the significance of Middle West industries in the social and economic fabric of the nation and the

world. As a contribution to this objective, the chemistry and economics teachers planned and taught a cooperative course through the year 1941–1942. The specific purposes of the course were knowledge of the flow of materials and energy from natural resources to consumable goods and services and of the problems that arise for human beings in the process; ability and willingness to use scientific methods in thinking about both scientific and social phenomena.

At the beginning, the two classes were conducted separately. In chemistry, the students started by studying the structure of the universe and matter and energy; then they moved on to more detailed study of minerals—their deposition, extraction, and uses. At the same time, in the economics class, students considered the different kinds of societies man has evolved, especially in relation to his changing understanding of the world.

In both classes the beginning work led to study of Detroit as an industrial community. The distinction between science and economics was less clear here. In analyzing the industries of Detroit, the students were stimulated by their science work to study application of chemical principles and processes; economics stressed the personal and social problems arising from life in an industrial community. Later sections of the work were devoted to distribution of natural resources, industries and populations in various regions of the nation and of the world and the interrelations among them. The intellectual and cultural level of the students made it possible for them to read widely in the fields of chemistry, economics, and sociology. They read technical reports as well as textbooks and semipopular presentations. In addition, the teachers and members of the Bureau staff prepared for them a pamphlet entitled *You and the Wealth of the World.*

A number of pre- and post-tests were given to this class and to control classes. The results in both knowledge and attitudes led the teachers to consider this a successful venture from the standpoint of the students. However, they felt that the experiment had been costly in teachers' time. They recommended,

therefore, that a number of periods each month in all science classes be devoted to the sociological aspects of the specific subjects and that the economics teacher lead these class discussions, after conference with the science teacher. This was felt to be peculiarly suitable to Cranbrook, since the new science building there provides an office for the teacher of economics in close relationship to the science laboratories.

Correlation of Biology and Home Nursing
(George Rogers Clark High School)

At George Rogers Clark School an interesting modification of the biology course was worked out by the teacher and the school nurse. In this school, as in all schools, many absences are the result of illness, sometimes of students themselves, sometimes of other members of their families. The school nurse made a number of simple studies aimed at discovering the extent of the sickness problem in the community and some of the related factors. A little investigation revealed a shortage of hospital beds. This coupled with the financial level of the community pointed to the inevitable conclusion that illnesses of all kinds were being cared for in homes.

Visits to homes of students and a questionnaire study showed a high proportion of chronic illnesses in addition to the expected number of communicable diseases. Another questionnaire disclosed the fact that students in general knew little about nursing procedures or about prevention and care of colds, headaches, and other minor ailments. In other words, students were being called on to assist in the care of sick mothers, fathers, grandparents, and siblings without adequate knowledge of how to do it skillfully or safely. They were also ignorant as to the treatment of the common ailments responsible for a great many of their absences from school.

As a result of these surveys, the biology teacher and school nurse cooperated in extending the biology work into the field of home nursing. For example, when the class was studying foods,

the school nurse discussed diets used in cases of diabetes, nephritis, and other chronic conditions. She demonstrated the serving of food to bed patients, with emphasis on ease of handling and appeal to the appetite. The class studied the meaning, dangers, and errors in treatment of gastric disturbances, indigestion, and appendicitis. Special reports were made on food-poisoning, on activities of state and national agencies, and on the Hammond ordinances related to food-handling.

Similarly, in units on circulation, respiration, and excretion, the school nurse gave demonstrations and led discussions on the practical applications in homes of the biological facts and principles studied. The unit on communicable-disease control gave special opportunities of this kind.

The teacher and the nurse planned the course together. The teacher was present at all class meetings and could help the students tie the special applications made by the nurse into their general biological background. The nurse, when she led the class, was familiar with what had been studied; consequently, she gave specific techniques and procedures more meaning than if they had been presented as isolated skills. This was an interesting example of integrating an applied field with a more theoretical one.

Unified Studies (Secondary School, Colorado State College of Education)

The lower division of the secondary school on the Colorado State College campus is not divided into grades or departments. The students are grouped according to interests, maturity levels, and previous experiences. The day's program provides opportunity for work in music, art, and literature; for physical activities; for individualized instruction in the basic techniques of mathematics, reading, and speech; and for what are known as *unified studies*.

In the third year, these unified studies had centered on experiences in the community. As a result of study at one of the Bureau workshops, the cooperating teacher prepared to extend and

reorganize the experiences offered in the unified studies. The region was to continue to be the focal point of study, but relationships of this region to other regions were to be stressed.

Questions were formulated relating to the ways in which land, materials, weather, and other natural phenomena determined food, housing, occupations, trade, and people's ways of living in general: What are our natural resources and where are they located? How have these resources been used? Who are the people living here and where did they come from? How has transportation developed in this region? What goods and services are produced here? What goods and services are imported? exported? How are people housed in this region? how fed? how governed? What are their health problems? What effect has distance from neighbors and from cities had on the lives of the people? How is water obtained? What effect have the weather and climate had on the use of the land? What is the future of this region?

Activities that would lead to answers to these questions were suggested: making population maps; interviewing geographers, county agents, and other experts; visiting industries; field trips to study plants and animals, natural resources, and irrigation developments; library and laboratory study of soil, minerals, farming, and mining; study of the literature of the region.

These tentative plans were worked out by the cooperating teacher as the result of his own study. They were presented to the school staff for discussion and modification, since the curricular framework of the secondary school at Greeley is the result of cooperative work of the staff. Specific questions for class study and specific activities were worked out by teachers and students as classwork proceeded.

English-Science Course (New Trier High School)

Throughout its history New Trier has carried on repeated experiments with curricular organization and methods of teaching, mostly directed toward meeting the needs of the superior students, who form the majority of the school population. For a

few years before the war, the students in the ninth grade with highest ratings on intelligence tests and highest recommendations from elementary-school teachers were placed in a combined English-science course. This course was planned and taught by two teachers, one with special interest in English, the other trained in the field of biology. Emphasis in the course was on development of basic understanding of the nature of the world and the universe, of man, and of the effect of increased scientific knowledge on man's social organization and social problems.

With students of the type assigned to this class it was possible to study technical details of a fair degree of difficulty and also to reach broad generalizations beyond the grasp of most children of this age. One measure of the success of the course lay in the mastery of scientific facts and generalizations shown by the students. Another evidence of success lay in the interest developed by the students in the field of science, an interest that led more students to elect biology in their tenth year than had elected it in previous years.

SECTION III. New Emphases within Existing Courses

CHAPTER 6. Human Development and Growth

The changes through which human beings pass from conception to death and the significance of these changes provided one of the continuing centers of work for all the cooperating teachers. The workshop of 1941 was devoted largely to study of adolescents, with emphasis on the physical, mental, emotional, and social changes through which they pass. One clue to understanding the 12- to 20-year-olds is through understanding of the babies and children they so lately were and the adults they will so soon become. Undoubtedly, every cooperating teacher thought differently about his students and handled his classes differently because of the insights and knowledge he gained through experience at that workshop.

Teachers of the biological sciences felt that they had peculiar responsibilities to modify the content of their courses so as to include material from this field. Adolescents perhaps more than any other age group need understanding of themselves. The human life span suggests a framework within which a multitude of specific details can be organized. It helps in development of perspective on immediate problems. It contributes to realistic and desirable attitudes toward oneself and other people. It gives a background for understanding the constantly changing relationships within families and in the many social groups in which we all play our parts.

MODIFIED COURSES

The concept of the human life span was included in a number of courses in biological science in the cooperating schools. In a

few schools, it was taken as an organizing center for a multitude of facts usually taught in smaller units. In other schools, it became a summarizing unit. In still others, one or two stages of development were given special consideration. In most cases, study of reproduction was put into the context of the life span, whereas previously it had been dealt with in a special unit.

In general, the total life span was divided for study into prenatal life, birth, infancy, childhood, adolescence, maturity, and senescence. Study usually started with the anatomical and physiological changes that occur in the various stages. Recognition of these changes was used as a means for better understanding of the emotional responses and the behavior of individuals of different ages. Discussion of emotional responses led directly into discussion of problems important to the students, problems that cut across subject-matter lines and stimulated students to organize ideas drawn from many fields.

The emphases in the various classes showed interesting differences. Tenth-grade students seemed uniformly interested in problems of their own relationships to parents. High-school seniors and college freshmen were looking forward to marriage and themselves becoming parents. Prenatal life evoked impersonal curiosity and questions from all.

Writing autobiographies in some schools provided students a means for looking back and recognizing developmental sequences in their own lives to date. As would be expected, it was not easy for them to look ahead and imagine themselves going on through adult life and senescence.

In many cases, the curricular changes meant changed emphases and perspective rather than new subject matter. Almost all problems of human beings, even those as divergent as diet and delinquency, require consideration of the ages of the individuals involved and their progress toward maturity. Our deepest emotions are associated with the phenomena of the life span, its beginning and its end, our own development and our relations with parents, mates, and children. An organization of learning that

gives perspective on life seems to have a value beyond that of presentation of isolated facts and experiences.

STUDY OF HUMAN DEVELOPMENT AND GROWTH BY TENTH-GRADE STUDENTS

Study of human development provided the theme for the greater part of a year's work for tenth-grade students at Lincoln School in New York. A semester at Glens Falls and almost that amount of time in the Fieldston School were devoted to the subject. In New Trier High School a short unit of about two weeks was given to study of adolescence.

Tenth-Grade Experimental Core Course (Lincoln School)

The course conducted by the science and English teachers at Lincoln School (see pages 63–64) dealt primarily with problems of human living that concern 15-year-old boys and girls. Emphasis was on helping these boys and girls to understand their own growth and development in a meaningful social perspective.

A preliminary discussion of the differences among the members of the class led to consideration of stages of human development. As part of this early work, each student "placed" himself on a time line. At first the time lines were short; gradually the class members broadened their ideas, going back first to birth, then to conception, next to their ancestors, and finally to the long line of beings that lived on earth before the emergence of man. Similarly, they thought forward to maturity and old age, with death as an inevitable and necessary part of life as a whole.

Over an interval of several periods, the teacher of English read aloud Gesell's article on Kamala, the Wolf Child, stopping often for discussion of Kamala's growth and development, and her problems of adjustment—first to wolf culture, then to human culture.[1] Emphasis was placed on the necessity everyone faces for adjusting to a broadening and changing environment.

[1] Arnold Gesell. "Biography of a Wolf Child." *Harper's Magazine*, January, 1941.

Study in general followed the stages in the life span, though there were many variations from this general plan. Interest seemed keenest in the study of young children; in many cases, at least, this interest had a personal reference. When asked "Why should we study babies?" one student answered: "We were babies. It is one way of studying ourselves." During the study of babyhood, the class visited the baby ward of a hospital under the guidance of the school nurse, saw and discussed several of Gesell's films from the Yale Institute for Child Study, and studied children in the laboratory and in a nursery school.

The students read a wide variety of articles and books, technical studies of development, popular books and articles in the fields of biology, psychology, sociology, anthropology, and literature, and high-school textbooks. In the laboratory they performed a number of experiments, chiefly physiological and psychological.

A continuing project throughout the year was the gathering of material for autobiographies. Each student wrote his own life-history, in any form he chose, but with emphasis on the reliability of sources consulted and on comparison of his development with what has been discovered about development of children in general.

Following is the outline which was distributed and discussed early in the term.

SUGGESTIONS FOR WRITING "MY AUTOBIOGRAPHY"

I. Gathering your personal data (sources of data)
   A. Your father and mother, brothers and sisters
   B. Your family doctor, records of birth, early and later attendance
   C. Diaries kept by yourself or your parents
   D. Picture records (arrange in chronological order if possible)
   E. Teachers and their records
   F. School records—health, attendance, etc.
   G. Other records available to you

II. Evaluating and interpreting data
   A. School nurse, school psychologist, counselor
   B. Books on psychology, child development, biology, and anthropology
   C. Class discussions, readings, laboratory work, motion pictures
   D. Observation of younger members in family
   E. Observation of children of different ages, in hospitals, in elementary school, on the street, in parks, etc.

III. Preparing your outline or questionnaire for gathering data (a first draft designed to develop techniques for obtaining significant data)
   A. Physical development. Outline or questionnaire should include at least the following
      1. Early body movements—use of hands and legs
      2. Eye movements, movements of head
      3. Changing position—to back from stomach, etc.
      4. Reflexes—withdrawing, sneezing, coughing, etc.
      5. Feeding responses—drinking, eating, swallowing, etc.
      6. Sitting, standing, crawling, walking
      7. Sleeping, resting
   B. Mental development—learning
      1. Manipulation
      2. Language
      3. Reading
      4. Play
      5. Number
      6. Responses to form, color, size, etc.
      7. Likes and dislikes with respect to foods, objects, sleeping arrangements, etc.
   C. Personal-social development
      1. Likes and dislikes with respect to people
      2. Table manners
      3. Dressing, care of self

4. Play with others
5. Communication
6. Learning social customs

ASSIGNMENT: You will be expected to prepare a first draft of an outline or questionnaire to help or direct your investigation of the history of your development as a human organism. This outline or questionnaire should come out of previous class discussions and discussions centering on these suggestions. Therefore (1) prepare your outline and submit it for approval; (2) redraft the outline in view of changes suggested in conference with instructor; (3) use the outline in carrying out your original investigation.

The result was a series of life-histories, honest and objective, closely related to the work of the class, interesting because of their style and organization and because they were unique documents telling the stories that only the writers could tell.

Tenth-Grade Biology (Glens Falls)

The tenth-grade biology course at Glens Falls was originally planned for students who did not intend to go to college. As a matter of fact, many of them would not finish high school.

Almost all the work of one semester was based on the concept of the human life span. This concept was used as an organizing framework for a wide variety of facts.

The introduction consisted of a general overview of plant and animal life. Life-cycles of plants, protozoans, insects, and frogs formed the background for the questions: Do human beings live through a life cycle? Do they go through changes as these other living things do?

The class listed stages in the human life span from birth to death but omitted any mention of the prenatal stage. When this omission was pointed out by the teacher, more questions were asked about this first stage of life than about all of the others.

A growth curve was put on the blackboard and served as a

starting point for the study of the prenatal period. The class studied fertilization, cell division, the development of bones, teeth, and other organs, and the effect of endocrine secretions on rate of growth. The rapid growth of the embryo and foetus was considered in relation to the need for good nutrition on the part of the mother. Questions about prenatal impressions and birthmarks were answered in terms of development and the prenatal relationship between mother and child.

Birth was studied from the standpoint of the adjustments a baby must make in changing from a uterine environment to one of greater independence. Birth rates in the community from 1850 to the present and causes of infant deaths were discussed.

The class considered, with great interest, the possible impressions that an infant might have of the world. This led to study of the sense organs and nervous system. A number of experiments were performed involving reflexes and conditioning: for example, learning not to wink when a glass is held in front of the eyes and wads of paper thrown against it.

At this point two babies were brought to class by their mother. The students weighed and measured them and kept records of their behavior. They were especially interested in the emotional responses of the babies.

The next phase of the work was called "The Child Growing Up" and led into study of learning, heredity, and the meaning of a good home environment. The previous observation of two children stimulated the question "What should children eat?" The students kept records of their own diets, studied menus, fed some pet rats that were suffering from vitamin A deficiency, and in general carried out the many activities related to study of nutrition.

As might be expected, the class gave the most time and interest to study of adolescence. The physical aspects of development, the growth spurt, and development of organs, including the sex glands, were studied in relation to changing nutritional needs and effects on posture, coordination, and appearance. There fol-

lowed a consideration of laws relating to adolescents, such as those on handling property, driving a car, leaving school, and getting married. The class members felt that many of the laws were not soundly based in scientific knowledge of how children develop. They discussed, sometimes heatedly, the differences between boys and girls in ability to take care of themselves, to become acquainted with the world, and to make decisions.

The relation of adolescents to their families was highlighted by an opinionnaire on problems adolescents should be allowed to settle for themselves, those their families should answer for them, and those that should be a matter of agreement between adolescents and parents. Seventeen items were listed on such problems as the hour for being home at night, use of the family car, appropriate clothes, choice of clubs joined, choice of friends, smoking, drinking, amount of spending money, choice of a vocation. Of all these problems, the class chose as most important smoking, drinking, and choosing a vocation. In relation to smoking and drinking, the teacher tried to show the physiological facts and, in addition, tried to point out the role of social pressures. He referred especially to the responsibility of older students for the junior-high students, many of whom start smoking in an effort to appear "grown up."

Too little time was left for adequate study of adulthood and senescence. Changes in physical status were related to changes in recreation and work through questions, such as "At what age do people cease to be successful as coal miners, artists, boxers, aviators, and college professors?" Opportunities given to men and women in the community were compared. Diseases, accidents, and causes of death were listed for the two sexes.

For all parts of the semester's work, the teacher prepared laboratory directions, study guides, and reading material adapted to the level of the class. Extensive use was made of pictures and diagrams. The lack of simple reading material was one of the acute problems faced by the teacher.

As part of the evaluation of the study of the human life span,

the students wrote summaries of the various age levels, including the characteristics of people at different ages, their social relationships and responsibilities, and the hazards of disease and death.

Each student compared his own life with the life-history of a real person, which had been written for the class in simple language.[2] In addition, the English teacher asked his students to write their own autobiographies and turned them over to the biology teacher to read. From an analysis of these papers, the teacher felt that the students had gained from the course increased understanding of the changes that take place during the human life span. He hoped that, as a result of this understanding, they would be better able to organize and live satisfactory and effective lives.

Tenth-Grade College-Preparatory Biology
(Fieldston Ethical Culture School)

A unit entitled "Life Span" was incorporated in the biology course at Fieldston Ethical Culture School and scheduled for the latter part of the year. However, the concept of progressive change in all living things as they go through life was illustrated and developed in all the units.

The year's work started with about three weeks devoted to general orientation to the study of living things. The class discussed such questions as: What are living things? How do human beings differ from other living things? What are normal differences among human beings?

Study of the last question introduced the idea of changes through a person's lifetime. Pictures of people at various ages were arranged as a bulletin-board display. All the students wrote papers on "What will Shirley Temple be like at 40?" and "What will I be like at 40?" Interestingly enough, while all the students realized that Shirley Temple's experiences as a child and young

[2] Adapted from "A Life History," by Anita D. Laton, *Science Education*, November, 1943.

girl would influence her future, few showed a corresponding realization for themselves.

Some of the students read a brief discussion of changes throughout the human life span[3] and planned projects they would like to work at through the year. Following the policy of the Fieldston School, students were encouraged to draw on other interests and fields in the development of these projects. For example, one boy with special interest and ability in music decided to compose music illustrating the various stages in life. The theme of one composition was the rhythm of the heartbeat. Another with talent in modeling planned an elaborate project with the help of an art teacher. This involved the construction of models of infants, children, adolescents, adults, and old people. He started work on models of a baby girl and a baby boy and hoped that future students would complete whatever of the series he left undone.

After this introductory work, the class embarked upon a study of the functioning of the human organism. Changes through the life span were stressed continually. For example, in the study of digestion, diets suitable for infants, adolescents, adults in various occupations, and the aged were studied. Study of changes in the human organism provided for objective discussion of marriage, homemaking, and vocations—subjects that were very close to the students' hearts, since at that time the war was beginning to change all of their plans for the future.

Next, the class undertook a study of genetics. This study went beyond fruit flies and waltzing mice to a consideration of human genetics, with stress on understanding of human differences and likenesses, among individuals and among races.

Study of diseases followed the study of genetics. In addition to the usual study of common communicable and noncommunicable diseases, the age-level distribution of diseases was stressed.

All the work described in the preceding paragraphs formed a

[3] Anita D. Laton. *The Life Span*. Mimeographed. Bureau of Educational Research in Science, Teachers College, Columbia University, New York, 1939.

background for the unit on life span itself, which began with a discussion of biographical motion pictures and books. From the overview of the stages in life gained from the preliminary discussion, the class moved to the study of one age level after another.

As work progressed, each student made a collection of materials, which he classified according to the age levels concerned. Some of these materials were clippings from newspapers and magazines. Others were pamphlets from governmental agencies, labor unions, manufacturers' associations, and other groups dealing with individuals of various ages. Since there is a scarcity of reading material on human growth suitable for high-school students, the teacher provided mimeographed excerpts from a number of sources.

As each stage in the life span was discussed, the teacher attempted to bring in artistic, literary, or musical interpretations as well as scientific and sociological facts and interpretations. The musical composition built around the rhythm of the heartbeat which a boy wrote for the prenatal stage of development (see page 79) represents an unusual illustration of this procedure. In connection with the prenatal stage, the class saw a film of the development of chick embryos, studied charts of human development, and read a summary of Gilbert's *Biography of the Unborn.*[4]

Following consideration of the prenatal stage, the class studied the adjustments an organism must make at birth, looked at the pictures from *Life Magazine* on "Birth of a Baby," and read Strain's *Being Born.*[5] The students compared infant mortality rates from various communities and various countries and studied ways in which communities are trying to reduce these rates through prenatal care, hospitalization, and education of parents. Firsthand studies were made of young children, at home and in nursery school. Emphasis was on psychological, as well as physical, development.

[4] *Reader's Digest,* August, 1939.

[5] Frances B. Strain. *Being Born.* Appleton-Century Co., New York, 1936.

In their study of the adolescent level, students drew on their own experiences. Social pressures and increasing community responsibilities were considered in relation to physiological and psychological changes in individuals. Some of the anthropological literature provided interesting material on the attitudes of other cultures toward children and adolescents.

Similar studies were made of adults and the aged. Naturally, however, interest in these age levels was less keen than in adolescence and infancy, and less time was spent in considering them.

Tenth-Grade Biology (New Trier High School)

The biology class at New Trier High School spent a short time in study of the life span. Like the other tenth-grade classes reported, the students' interest was primarily in adolescence. As the teacher remarked: "These students are interested in themselves and in those aspects of biology that directly affect them."

Probably more than in any other school, these students brought in personal problems for class discussion. For example, great interest was shown in the relations between parents and their adolescent children. The teacher submitted a list of problems that at times have been points of conflict in families. Some of the problems listed were choosing friends, hour of coming home at night, use of spending money, using the family car, home duties, owning and using a key to the home, and choosing one's own clothes. The students selected the problems that they felt caused most difficulty in their own homes and discussed them as objectively as possible. The teacher stressed the need for trying to see the parents' point of view. In every statement about arguments at home, he led the students to see ways in which they could prove to their parents that they were trustworthy and "grown up." At the end of the discussion the class wrote papers on "How can I get along better with the family?"

It seemed reasonable to hope that objective discussion of these problems at a time when the boys and girls were not under emotional strain would help them to be more self-controlled when

the need arose. One interesting and somewhat amusing episode occurred when a boy came to class in great indignation because he had been denied the use of the family car. He angrily offered his case as a subject for discussion when the teacher asked whether the class had questions. While sympathizing with him, the other members of the class had a number of things to say about his parents' being interested in his personal safety and being legally responsible for any damage he might do with the car. Though not completely convinced, he was obviously less upset and more able to discuss the matter from two points of view at the end of the period than he was at the beginning.

UNITS ON HUMAN DEVELOPMENT IN ELEVENTH- AND TWELFTH-GRADE CLASSES

In Denby High School and Arsenal Technical Schools material concerning the human life span was introduced into nonlaboratory courses in physiology given in the eleventh and twelfth grades. At Denby all the stages in the life span were discussed. Greatest interest was shown in relations between, and mutual responsibilities of, parents and children. At Arsenal Technical Schools questions and discussion were centered on heredity as a limiting factor in development and on problems of family living.

Eleventh-Grade, Noncollege-Preparatory Physiology (Edwin Denby High School)

Edwin Denby High School offered a noncollege-preparatory course in physiology; it was a nonlaboratory course, whose main objective was health education. One of the teachers assigned to the course felt that a large part of the work should be built around the stages in human development. With this plan in mind, he selected objectives from a list that had been prepared by the Bureau staff on the basis of work with previous classes in other communities. The following objectives were included.

Understanding of variations in rate of development, of differences between boys and girls, and appreciation of the meaning of these for a person's feeling about himself and for what the community expects of him

Understanding of the part that care of the organism during youth has on efficiency, health, and success later in life

Willingness to look forward to adult life and old age and to prepare for the physiological, psychological, and social changes they bring

Realization that people are influenced by the physical and cultural environment

Willingness to subject prejudices to scrutiny in terms of present knowledge; willingness to apply the results of scientific research in making decisions

Appreciation of the legal, financial, and moral responsibilities of parents for children, of children for parents; appreciation of the changes brought about in these relationships as parents and children go on from one age level to another

The class listed the stages of life and decided to study them in chronological order. In fact, one of the beginning units went back beyond even the earliest stage in life and considered the relations of heredity and environment. The teacher stated that it is the ambition of parents to bring up children who are intelligent, well mannered, and a credit to the family and to the community, whereupon the question arose: "But, how can one be sure of having intelligent children?" A girl suggested that "if you marry a man who is intelligent and are intelligent yourself, the chances are pretty good that your children will also be intelligent." It was pointed out that this assumed heredity to be of greater importance than environment. Another student countered with: "But suppose that environment is the more important. How then should one make the most of it?" The class sug-

gested, in this case, that one should send a child to a nursery school, give him music lessons, push him in every way possible, discuss politics and current affairs instead of only "talking to him about bow-wows." Since present knowledge indicates the significance of both heredity and environment, the class concluded that people must keep both in mind in choosing a mate and in bringing up children.

Since for many important questions we have only half-answers, if any at all, the class had much opportunity for practicing that aspect of scientific method which has to do with deciding on action, while recognizing that our knowledge is inadequate and that we must be ready to change a decision when new data have been brought forward.

Study of the prenatal stage brought an emphasis on the total dependence of the unborn organism on the mother. Consequently, in study of the later stages of human life, the development of physical and psychological independence was stressed.

In connection with a brief study of birth, the importance of birth certificates was discussed. The day's assignment included making application for birth certificates for students who did not already possess them.

Most of the time was spent on study of adolescence. Each student wrote a brief paper about himself and his relations with other people. In some cases, as would be expected, this was a perfunctory and generalized statement. Other students gave clear descriptions of their places in their own families, their social activities and friendships, their assets in developing satisfying social relationships, and their goals in life. All the statements were objective. One interesting point is that all of them were also constructive. Reading the papers gives the impression that the students' thinking had been led along lines of appreciation of satisfying human relationships and of self-confidence in achieving them.

Study of the older age levels was largely in terms of the adolescents' relations to their parents, then and in the future when

they would be adults and their parents would be aged. The changing physical and physiological characteristics of adults and the aged were brought out in relation to potentialities for independence.

Lively discussions were held on what children owed their parents, what parents owed children, and what both owed society as a whole. There was general agreement that the community should give all children a high-school education because of its citizenship values. Opinion was divided as to whether all should be given a college education for the same reason. A number of students were surprised when they realized that children cost their parents a considerable amount of money and effort and that the legal responsibilities parents carry for their children are heavy.

The question "Should you expect to pay back to your family the cost of your college education?" started an interesting and revealing discussion. Many inclined to the comfortable belief that parents get their greatest satisfaction from a child's success and would not wish repayment. A few thought parents should be repaid, even though they might not need the money.

The question of what was due to parents in old age brought still more divergent opinions. Some thought care of parents who needed it should take precedence even over care of one's children. Others bluntly said that the older generation had had its chance, now was the turn of the younger generation. Most of the class felt that parents would not expect their children to deprive themselves in order to care for them. Insurance and old-age pensions were discussed as means of avoiding difficulty.

The assignment following the discussion described in the foregoing paragraph was for each student to discuss the matter with his family. The students were to find whether their parents felt that educating their children was sufficient satisfaction in itself, what they expected of their children later in life, and what responsibility they felt for their own parents. About half the students said that they had never discussed getting old and all it would mean with their parents.

The following week the students brought in reports of their conversations. Practically all found that their parents did not feel their children were obligated to pay for their educations. Parents did, however, want to be able to depend on children in the future if the time ever came when they could not support themselves. When asked whether these attitudes were worth finding out, one student voiced the opinion of many when he said, "Yes. Now I'll plan on it. I won't go through life thinking I don't owe them anything."

Eleventh- and Twelfth-Grade Class in Physiology (Arsenal Technical Schools)

Material on stages of the human life span had not previously been included in the physiology course at Arsenal Technical Schools. The class was composed of both boys and girls, somewhat above average intellectually but with little background in human biology. The teacher approached the subject through study of heredity and was careful to base all his statements on scientific facts rather than on personal opinion. As he stated, "A class has plenty of personal opinions of its own." He also concluded that most students "know less than one would expect."

Discussion was started by presentation of a series of charts showing fertilization and Mendel's laws of heredity. At one point, the teacher asked whether the students would be disturbed if they discussed in class such questions as: What is a Caesarean operation? Are illegitimate babies normal? The students agreed that these would probably be more valuable than some other topics, such as names of the bones. After a few days, students began staying after class to ask questions about specific problems concerning themselves or their families and friends.

Only two weeks was spent on the life span, so study was pretty well limited to the general principles of heredity, how these principles should influence one's choice of a mate, and other factors to be considered in successful family life. At the

end of the study a number of questions were asked on such subjects as prenatal impressions and prenatal and child care.

The students also wrote papers on "My Philosophy of Life in Relation to Marriage." These papers did not follow a set pattern, but each included several aspects of marriage that the writer thought important, such as economic stability, religion, character, heredity, and children. All showed a feeling that the class discussions had cleared up some questions and had helped to set high standards. The teacher's conclusion was that the study of the life span was of vital interest to the students and, if carefully presented, could be of great usefulness in clearing misconceptions, answering questions, and giving a more constructive view of marriage and family life.

UNIT ON THE LIFE SPAN IN A COLLEGE FRESHMAN CLASS

Thirteenth-Grade Class in Biological Science (Colorado State College of Education)

The students in the thirteenth grade at Colorado State College of Education were older than any others included in the Bureau study. A unit on the human life span was included in the course in biological science. The presentation was largely by lecture and demonstration. The class participated in discussion and read a wide variety of books and magazine articles.

Each student selected a topic for independent study. The reports of these studies were incorporated in a 70-page booklet called *We March*. These reports provide a revealing picture of the meaning that ideas about the life span had for the students making them.

The booklet is divided into sections. The first is entitled "An Introduction to the Life Span" and deals with heredity and fertilization. Then follow sections on the prenatal period, infancy, childhood, youth, adulthood, and senescence. Interestingly, the

section on youth is titled "Into the Unknown"; that on adulthood, "Out of the Unknown." Summaries of the physical, mental, and emotional changes that occur in boys and girls and in men and women are given for each of these age levels. The last third of the book deals with questions that seemed of special interest to the class. One section on "Effects of an Understanding of the Life Span" includes reports on "Understanding the Opposite Sex," "Choosing a Mate," "Making a Success of Married Life," and "Making a Success of a Single Life." Each, except the last, was presented from both a man's viewpoint and a woman's viewpoint. Another section was titled "The Ability to Face Reality" and contained men's and women's views on what to expect as one lives through his life span, adjustments that must be made, and changes in social relationships that occur. Some of the reports were based on reading, others on firsthand studies conducted among the students on the campus.

In closing, the editors say: "This then is our perspective on the life span. Save it. In 1961 reread what you have written. You will read it with an abundance of experience behind you. World War II will have ended, perhaps the problems of Socialized Medicine, Birth Control, and Education will be solved. Let your grandchildren read it. Will they consider it interesting but out-of-date? Are they facing the same realities, the same problems you faced?"

CHAPTER 7. Understanding Our Natural Resources

"Science is profoundly changing the kinds of outlook that man has toward the physical and biological aspects of the universe that surrounds him. Man has become an important factor in changing the environment. His continued existence and advancement are dependent upon his wise modification and utilization of the environment. In a few centuries he has greatly changed the North American continent. He has drained swamps, cut down forests, built cities, introduced exotic species, exterminated certain indigenous ones, built artificial lakes, changed the course of streams, and altered the original balance of nature.

"Species of living things have survived because they have tended by adjustments and adaptations to become better fitted to the conditions under which they live. In general, man is no exception to this basic principle, but he can change the conditions of his environment to a far greater extent than any other kind of living thing."[1]

From the beginning of the work, members of the Bureau proceeded on the premise that teaching is effective when it is rooted in the needs and problems of people in the community—local, national, world. They felt that "plans must be laid on a world-wide scale to develop latent resources, to increase productive power, to raise standards of living, to maintain the flow of materials and energy through communities, and to enable men to see themselves and their communities in a rising scale of well-being within the framework of international relations."[2]

[1] Gerald S. Craig. "The Social Role of Science." *Teachers College Record*, January, 1944, p. 219.

[2] Anita D. Laton and Elsa M. Meder. "Toward Unified Learning." *Teachers College Record*, January, 1944, p. 233.

Faced with the challenge that "needs of young people will best be met through the kinds of learning experiences whereby they come to understand that their ultimate welfare is identified with the welfare of their community,"[3] many of the cooperating teachers revised their courses to place emphasis on the two great areas, interrelations of living things and use of materials and energy. They relied heavily on the viewpoints expressed in *Life and Environment*, by Paul B. Sears, and *The Storehouse of Civilization*, by C. C. Furnas.[4]

STUDY OF THE INTERRELATIONS OF LIVING THINGS

Conservation has always been one of the major fields of interest for alert biology teachers and their classes. Recent work in the field of ecology has given study of conservation an underpinning of general principles which was necessarily lacking or inadequate earlier. At one of the first workshops of the Bureau considerable time was spent in discussion of *Life and Environment*. In this volume Paul B. Sears presents a picture of the ever-changing interrelationships in plant and animal communities, which tend toward equilibrium but never become static. He goes on then to use these ecological generalizations in the interpretation of human communities.

The concepts thus presented were reflected in all the community surveys made by cooperating teachers (Chapter 1).

In addition, all the schools developed units, or expanded already existing units, specifically concerned with conservation of our biological resources. These were usually included in courses in biology. Many classes approached the study of conservation from the standpoint of ecology and included human communities, especially the students' city or region, in their discussions.

[3] Samuel R. Powers. "Foreword." *Teachers College Record*, January, 1944, p. 218.

[4] Both books were prepared in the Bureau of Educational Research in Science and were published in 1939 by the Bureau of Publications, Teachers College, Columbia University, New York.

Usually a unit dealing with one topic was included in one or more classes; often it was a unit on conservation of one kind of plant or animal. In one school, however, the idea of the interrelatedness of plant, animal, and human communities proved the organizing center for one semester's work. In at least one school, students felt the significance of conservation sufficiently to make it the center of an extracurricular project.

Members of the Bureau staff prepared pamphlets entitled *Plant and Animal Communities*, *Forests and Man*, and *Plants and Animals for Daily Use* for students. They were accompanied by pre- and post-tests designed to find changes in information, skills, ability to apply information, attitudes and interests. The pamphlets and tests were used experimentally in a number of schools.[5]

Variety of Projects Related to Conservation at Arsenal Technical Schools

During the war the teachers and students at Arsenal Technical Schools became very conscious of the desirability of their participation in the war effort. Conservation and health were stressed throughout the school. While thought was then directed primarily to problems of war, the same thinking and many of the same activities now make their contribution to thinking about the problems of peace.

Since Arsenal Technical Schools possess a large campus, many of the interrelations of plants and animals can be studied by first-hand observation and experimentation. The Nature Preserve is 4½ acres in extent and includes plant groups in eight kinds of habitats—forests, bog, open field, lake, sand dune, and so on.[6] Records are kept from year to year to show the changing weather and soil conditions and the successions of individual plants and even species, all within a general pattern of stability.

On the immediately practical level, the agriculture teacher di-

[5] Charlotte L. Grant. "Some Techniques in the Teaching of Conservation." *School Science and Mathematics*, May, 1943.

[6] Charlotte L. Grant. "The Use of the Arsenal Technical High School Nature Preserve in the Teaching of Conservation." *School Science and Mathematics*, October, 1942.

rects students in the care of flower and vegetable plots. Through World War II his lessons in gardening were printed serially in an Indianapolis newspaper. During the war, also, botany and biology classes developed demonstration Victory gardens as part of a unit on gardening. They prepared exhibits for the halls showing garden tools, seeds, garden preparation and cultivation, and destructive insects. Two classes kept a written and photographic record of the campus garden. One botany teacher stressed the adaptation to our climate and conditions of foreign plants from which we may obtain foods, fibers, and medicines and drugs.

The cooperating teacher in Arsenal Technical Schools took leadership in the Bureau in the preparation of the aforementioned pamphlets for students. She developed in her own classes the suggestions for projects in the school and community that are listed in the pamphlets. She was interested not only in developing knowledge but in stimulating attitudes and skills that would lead students to use the information gained in better conservation practices. The following activities were included.

Reports on soil, water, forest, and wildlife resources; relation of depletion of these to shortages

Exhibits on wastes and losses through fire in lumbering and agriculture

Exhibits showing interrelationships of plants and animals

Preparation of maps of national and state forests and parks

Reports on city parks and preserves

Study of lumber: sources, flow into Indiana, uses, substitution for metals

Study of fiber plants, medicinal plants and animals, rubber, sugar plants, beverage plants, spices and substitutes

Succession studies in various habitats

The Nature Study Club, an extracurricular organization, carried out a special war project under the auspices of the United States Forest Service. Materials sent from the Forest Service were presented by student panels. At the close of the project, a program was presented before the Indiana Nature Study Club. Students gave a round-table discussion on forestry and forest conservation. This was followed by a sound film "Trees of Tomorrow." Participating students were named as junior deputies in their own communities by the Forest Service.

Plant and Animal Communities the Center of a Semester's Work at Glens Falls

Study of plant, animal, and human communities became the organizing center for one semester's work in the non-Regents biology class in Glens Falls High School. The idea of successions moving toward a climax population was developed early in the term and applied to Glens Falls itself.

Forests afforded one of the chief reasons for the founding of the town and have remained a leading source of raw materials for saw mills and paper factories. The students thought back into prehistoric times to find something about the soil and the climate that made the growth of these forests possible. Study was made of plant successions as they develop today on bare rock surfaces, and the students tried to envisage the long processes by which a climax forest population might have developed about Glens Falls.

Special attention was given to destructive agencies, such as fire and unintelligent cutting, that had operated at various times and had almost destroyed the forest on which many Glens Falls industries depend. The class visited a pulp factory in which many of their parents worked and heard the owners' plans for conservative cutting on a crop basis.

A central problem of conservation in Glens Falls is the water supply. The class became acquainted with the city forester, whose job it is to care for the forests and carry out reforestation

in 4000 acres of the city's watershed as well as to supervise the hundreds of street trees in the city.

Committees of students reported on a number of the resources originally found in Glens Falls, such as trees, flowers, insects, and game animals. They gave special attention to the factors, many within human control, that had acted to destroy or to encourage the growth of these plants and animals. One boy made a frieze for the classroom showing the many destructive agencies that had been, and in many cases still were, at work in the community.

Teaching in this class is hard to describe briefly, because the basic ideas were brought up again and again in many connections. The students continually saw themselves and the life of today on a time line extending far into the past and far into the future. When they made gardens, their attention was drawn to the fact that they were digging into the old delta of the Hudson River formed below a lake made by melting glaciers. At another time a trip to newly planted areas led them to try to project their thoughts into the future and to see the effects of reforestation on industries and ways of living of people yet unborn.

Although the major portion of the term was spent on study of Glens Falls, some attention was given to its relations with the nation and the world. Organizations, governments, research, and various scientific aids were shown as assisting in establishing balanced communities at a high level of welfare for man.

New Supplementary Materials Related to Conservation Developed in Cleveland

Teachers in Cleveland are encouraged to prepare suggestions for teaching about topics related to, but not included in, the regular courses of study. These are called *departures* and are distributed to all interested teachers in the city.

An early departure was titled "Suggested Materials for Use in Teaching Conservation." Several others were concerned with gardening activities. One was limited to care of trees. This was

designed to be used in biology in connection with the unit "Simple Life Processes in Plants and Animals." Study centered primarily on street trees and the improvement and beautification of property through their use. Among other activities, students prepared reports on common blights and diseases that interfere with the growth of trees in and around Cleveland.

Some of the biology classes in Cleveland participated in experimental use of the pamphlets prepared in the Bureau. One of their suggestions was that pictures be used more extensively to show natural habitats to children who have traveled very little and had few experiences outside their own community.

USE OF MATERIALS AND ENERGY

From the beginning of the Bureau work, there was much interest in the study of materials and energy and their use by man. All the cooperating teachers were acquainted with Furnas' *The Storehouse of Civilization.* Teachers of the physical sciences especially felt that this book and the workshop lectures by Furnas had enlarged their viewpoint of the significance of their subject-matter fields. The coming of World War II gave even greater urgency to their efforts to develop consciousness of the importance of our natural resources.

In every school, the teachers endeavored to give students a realization of the physical resources on which their community depends and the flow of materials and energy through the community. Iron, copper, gasoline, and electricity were not thought of in far-off and static terms but in relation to everyday living and industrial prosperity.

One result of this emphasis was closer contact with extraschool affairs of the community. Students went on field trips to industrial plants and public utilities; specialists of various kinds came into the school. These contacts inevitably meant better understanding of the activities and needs of the community and region.

In several cases, students found jobs for themselves as a result of studying local industries. It is impossible to estimate how many others profited by the vocational exploration that the study afforded, though the number must have been large. In some schools and with some classes, this overview of the job possibilities in the immediate neighborhood was stressed. This was true in Trenton, Hammond, and Des Moines, which are fairly stable communities in which young people expect to live and work after leaving school.

In other schools, the stress was on the interdependence of the immediate community, whether large or small, with the rest of the world. Each region has its peculiar materials or sources of energy to contribute to others and each in turn draws on many other regions to supply the things it lacks. Colorado and the industrial region of the Middle West illustrate vividly this interrelationship.

Problems related to the use of materials and energy involve the whole world as never before. It has been said of geographical exploration that man now knows the extent of his patrimony upon this planet. Geological exploration is rapidly making the statement true for our natural resources as well. Unlocking many of our stores of materials waits upon development of new processes of extraction and manufacture. Use of our limitless supply of energy from the sun waits upon new techniques for changing it into usable forms. In a few of the cooperating schools, these considerations were stressed with classes and with individuals, since the future research workers and the directors of research are now in our schools.

In every school, the human elements were considered in the flow of materials and energy through the community. Labor problems and consumer problems were thought of as integral parts of the over-all problem of using our resources. Only at Cranbrook, however, were these given as large a place in the curriculum as the purely scientific problems.

Members of the Bureau staff and cooperating teachers pre-

pared a wide variety of teaching aids in this field for use by students. One, *Interest Inventory in Materials and Energy*, was designed to find what problems and topics students thought interesting and important. Seventy topics and questions were listed. Some were technical, such as "How to write chemical equations" and "How to make an analysis of a salt." Others pointed to the usefulness of scientific knowledge, such as "What is the cheapest way of heating a house?" and "The recovery of metals that have been used once." This inventory was used in several of the cooperating schools, sometimes at the beginning of study, sometimes at both the beginning and end of a unit of work, to find whether and how student interests had shifted.

Another instrument was the pamphlet, *You and the Wealth of the World*, prepared originally for use at Cranbrook School. This pamphlet gave an overview of the mineral sources of the world, and the problems of extraction from ores, refinement, manufacture, and distribution. It pointed out that these problems are both scientific and social.

All of the teachers recognized the need of better preparation for themselves in the fields of economics and sociology. All of them, also, were desirous of assistance from other members of the faculty who possessed greater competency in these fields. Integrated courses seem the only method for providing such assistance. These present administrative problems requiring whole school cooperation in their solution (see Chapter 5).

Flow of Materials and Energy through Hammond Studied in Chemistry Course

In the three years between 1940 and 1943, the plan of chemistry teaching at George Rogers Clark underwent a continuous change. The teacher was in close touch with the community; she was also alert to the problems of young people in Hammond and, through work on a national committee, in the country as a whole.

Hammond is an industrial community. It draws raw materials from mines, oil fields, and farms, and converts them into finished

products, which in turn flow out again to other communities throughout the world. It was one of the centers contributing directly to our war effort. Many of the students in the Hammond schools find work after graduation in the local industries.

For the first year of the cooperative study, two different courses were offered in chemistry. The first semester's work in both classes was devoted to certain fundamentals that it was felt all students should understand. In the second semester the college-preparatory class followed a textbook and a laboratory workbook. Emphasis was placed on practical applications of what was learned, and time was devoted to field trips and reports on current materials.

The noncollege-preparatory class, in its second semester, chose topics for individual or small-group study. The class met as a whole once a week to hear progress reports. One day a week was given over to the use of visual aids, to outside speakers, or to field trips. The teacher prepared guide sheets and reading lists and held weekly conferences with each group.

Students as a result of this work learned to see applications of chemistry in their daily lives and in the problems of the community. They developed initiative and learned how to find and organize material. It was decided, however, that the students in general were not prepared for individual work and that this kind of program demanded more teacher time than was available. It was felt, too, that the advantages of segregation were not sufficient to compensate for its disadvantages. Consequently, in later years college-preparatory and noncollege-preparatory students were placed in the same class.

In preparation for the second year's work, the teacher carried out a number of investigations. She sent questionnaires to 50 members of the community, ranging from housewives to industrial chemists, asking specific questions as to how the work in high-school chemistry could be made more practical and vital. Returns were disappointing, although complimentary, because the persons who answered had nothing to suggest beyond what

was already being done. The teacher interviewed laboratory technicians, executives, personnel directors, and others in local industries to find what qualifications they considered essential for successful laboratory work. She made trips to manufacturing plants, city laboratories, and sewage-disposal and filtration plants to obtain firsthand information about the chemistry involved in their activities. Material concerning local problems was obtained from the chamber of commerce, the city chemist, the city engineer, the local housing authority, labor organizations, and employment agencies.

The following goals for the class were set.

1) Development of initiative and self-direction
2) Knowledge of the fundamentals of chemistry in a form that will enable students to interpret and organize new facts and ideas
3) More intelligent membership in the community through knowledge of
   a) Relations of industry to the community
   b) Problems of industry affecting the individual
   c) Importance of chemistry in industrial processes
   d) Symbiotic relationships of Hammond with other communities
4) Realization of the chemist's part in the war and postwar effort
5) Preparation for intelligent participation in the industries of the community

Class activities included laboratory work and reading such as might be found in other schools. In addition, the program contained a number of unusual features. Evening meetings were held every two weeks to which students invited relatives and friends. Students were in charge of the programs for these meetings, which included reports and demonstrations and talks by outside

speakers. Joint sessions of the two classes were held weekly for group discussions, visual aids, or speakers. Individual students worked out projects on chemical processes involved in some of the local industries or made charts showing the flow of materials through the industrial plants. Trips were planned but because of war restrictions could not be carried out.

One unique outcome of the program was a cooperative venture between the chemistry classes and three of the local industries. Students in the second semester were given opportunity to substitute two weeks' work in industrial laboratories for classwork. This firsthand experience resulted in some valuable information about the industrial applications of chemistry and, in some cases, in permanent jobs for students after graduation.

Although no formal evaluation of this program was made, there has been evidence of its success. George Rogers Clark students continue to rank high on the Purdue tests, showing that the classes have not lost ground academically. A close cooperative relationship has been established between the school and local industries. Local chemists who have talked before high-school groups have expressed appreciation of the background and interest of their listeners. Students who have gone into college chemistry classes or into industrial laboratories have uniformly done good work. The subjective opinion of the teacher is that the close tie-up with the community is successful. And she adds, "I would not be happy teaching chemistry in any other way."

Study of Fuels in Chemistry in a Des Moines High School

Work on the community survey made by school and community leaders in Des Moines (pages 16–18) directed the thinking of many teachers toward helping students develop better understanding of their city and their region. The following account of the teaching of a unit on fuels in a chemistry class illustrates how one teacher attempted to build a closer school-community relationship.

The teacher presented informally an overview of the general topic of fuels, first defining *energy* and pointing out the sources of energy and the transformations of energy with which the students were all familiar in their everyday lives. Since coal-mining is one of the most important industries in Iowa and since several members of the class had relatives directly connected with the coal industry, the teacher included in the overview a description of the origin of coal as given in *The Storehouse of Civilization.*

In the discussion after the overview, the following questions were brought out by the students and accepted by class and teacher as topics to be investigated.

How was coal formed?
What is the distribution of coal deposits in Iowa?
What are some of the products that can be derived from coal?
What are the forms of carbon and what are the characteristics and uses of each form?
What are the sources and composition of fuel gases?
What useful products are derived from petroleum?
What are the characteristics of good liquid fuels?
What is cracking? flash point?
What are some of the precautions against, and the emergency treatment for, carbon monoxide poisoning?

With these questions as leads, each member of the class formulated his own outline for study. Then the students began to explore the usual sources of information: the classroom reference shelf and the school and city libraries. It soon became apparent that the community had other valuable sources of information. As a result, class excursions were conducted to the city gas plant and the local laboratory of the Great Lakes Pipe Company. Several members visited the sewage-disposal plant, some visited a coal mine, others interviewed gasoline-station operators. One student had an interview with the state chemist.

The nine original questions grew in number and some were broken down into more specialized ones. For example, a few

members of the class became interested in the subject of synthetic fuels. The question on fuel gases was divided into questions about natural gas, water gas, and gas produced for fuel purposes by the sewage-disposal plant.

Sixteen laboratory experiments were performed during the four weeks devoted to the study of fuels. Some were teacher- or student-demonstrations, while others were performed by each student in the class.

At the close of the unit, each member of the class presented an oral report of his work. Following the reports, each student made a list of new facts he had learned from this cooperative study of fuels. A committee of students tabulated and organized these newly learned facts.

No formal evaluation of this work was attempted, although the teacher prepared a thoughtful summary of the work and listed what he considered the values and disadvantages. On the credit side was, obviously, the large amount of factual material learned. In addition, opportunity was given to develop individual interests. An illustration of this was the case of a boy who spent all his leisure time for more than a month in building a model refinery. A visiting instructor in diesel engineering questioned him about refining processes and received satisfactory answers, showing that his work had contributed to his understanding as well as providing avocational activity. Another student brought in a number of coal balls and discussed them interestingly and well.

Increased parental interest was evident, as shown by help given by parents in the preparation of reports. Stimulus was given to individual work and research. One evidence of this was the unusual number of students observed working in the laboratory outside of their scheduled periods. Exploration of the community resources gave vocational direction to a number of students as well as building in all a better understanding of their own community.

One of the greatest difficulties encountered was that of providing teacher time for supervision of the many individual activ-

ities. The teacher concluded that it would be impossible to carry a full teaching load on a similar program.

There was a great deal of difference in the amount of work the various students accomplished. Many wasted time in getting started, and several definitely did not work up to their capabilities. Several, however, did far more than their previous records would have led one to expect. The teacher felt that some of these difficulties would disappear as students became accustomed to greater independence in planning and working.

While excursions into the community were of great value, they were attended by difficulties. The school schedule made excursions on school time almost impossible. Providing transportation was difficult, and teacher liability while on excursions remained an unsolved problem.

Study of Important Organic Compounds in Chemistry at Oak Park-River Forest High School

Traditionally, high-school chemistry has been devoted to study of inorganic compounds. Increasingly, however, our ways of living have come to depend upon our organic resources. The work of organic chemists has given greater understanding of these resources, has led to synthesis of new materials, and has extended the uses of reproducible raw materials. The importance of this field of chemistry was highlighted by the war.

As early as 1939, the cooperating teacher in Oak Park had included in his chemistry course a unit on soils and their relation to the food supplies of the region, especially with regard to mineral content. In 1942 he planned a more extensive unit on organic chemistry, to be incorporated in the second semester of the chemistry course. The outline in brief was as follows.

Historical background
  Synthesis of glass, of water, of urea
  Synthesis in development of fuels, foods, textiles, drugs, and plastics

Fuels
- Coal; products of destructive distillation
- Natural gas; polymerization
- Petroleum; cracking; hydrogenation
- Alcohol; possible future sources and uses
- Geology of coal and petroleum; conservation of these
- Combustion of fuels; home heating; automobile and airplane use of fuels

Foods and nutrition
- Photosynthesis
- Oxygen and nitrogen cycles
- Relation of nutrients in soil to dietary values of foods
- Composition, sources and uses of carbohydrates, fats, and proteins
- Sources and functions of minerals and vitamins
- Metabolic rates and their determination

Textile fibers, old and new
- Animal fibers: kinds, properties, tests
- Vegetable fibers: kinds, properties, tests
- Synthetic and manufactured fibers: rayon, "Celanese," nylon, "Vinyon," glass, others; manufacture, properties, tests
- Bleaching and dyeing; coal-tar dyes; use of dyes; relation between dye manufacture and manufacture of explosives

Synthetic resins; plastics; rubber
- Kinds of plastics; uses
- Problems in production of synthetic rubber

Class activities included laboratory work, reading, and discussion.

It was hoped that students would gain understanding, not only of the chemical processes involved, but of the meaning of these processes in furthering the war effort, in conserving our non-reproducible raw materials, and in raising our standard of living. Articles in current magazines were widely used in addition to textbooks giving the basic scientific facts.

Units on Fuels and Housing in a Physical-Science Class at New Trier High School

Most of the work of the physical-science class for nonacademic students at New Trier (pages 44–46) was related to man's use of materials and energy. The first few weeks were devoted to study of the forms and structure of matter, and chemical and physical changes in matter. A variety of simple laboratory demonstrations and experiments served to give meaning to the generalizations involved in these topics. So-called "key questions" formulated by the teacher were designed to encourage the students to think about the world around them and their everyday experiences rather than to repeat, parrot-like, a series of textbook statements.

A unit on fuels was taught following the same general principles. The key questions were developed in part by the teacher, in part by the class. They included such questions as: What kinds of fuels are there? What chemical changes take place when fuels are burned? What are some of the harmful substances resulting from the burning of fuels and how may we guard against them? How may we determine the burning efficiency of fuels? What fuels have men used in the past? How are fuels formed in the earth? What problems are involved in the conservation of fuels? What are the sources of fuels and how are they derived from these sources? What fuels do you use in your home and what is their cost? (The reports from the class on this point were summarized in chart form.) Where do the fuels used in Winnetka come from? How is the "smog" problem in Chicago related to the city's use of fuels? Why did Winnetka not ration gas when New York was forced to do so? Has the supply of fuels been curtailed in any way in homes? in industry?

The teacher suggested a number of activities that would help to answer these key questions. Other activities were added to the list as work progressed. A few of the activities were carried

on by the class as a whole. Others were chosen by individuals or small groups, who reported to the class. No single textbook was used. Instead, a number of books and pamphlets were made available, and students were assisted in the use of the library and the selection of materials.

Suggested activities were usually in the form of problems to be solved, for example, finding the difference between various grades of coal, testing the effects of carbon monoxide and carbon dioxide on defibrinated blood, and comparing viscosity of various commercial grades of oil. A few specific laboratory activities were listed, for example, making charcoal and coke from wood and coal, and demonstrating the construction of a gas meter.

The students made field trips to the village gas plant and to the models of coal mines and oil wells in the Chicago Museum of Science and Industry. They made a map of Illinois showing the location of coal fields and oil wells.

Problems for library research included learning how nations maintain their own national economy, with particular attention to the use of coal and oil. Other topics studied were measures to insure all countries an adequate supply of oil; what the annual production of coal and oil in Illinois and in the United States is; how many people are employed in this phase of our national life; what their working conditions are; and why there have been so many strikes in recent years in the coal and petroleum industries.

A timely unit was the one on housing. Study was made of the types of building materials used in various communities and of their value in terms of durability, strength, fire resistance, flexibility, and insulating qualities. The advantages and disadvantages and costs and availability of traditional materials were compared with those of newer building materials, such as steel, aluminum, glass, and plastics. This unit derived unusual interest and cogency from the emergency housing programs that so rapidly became a feature of our communities.

Trenton's Use of Natural Resources Studied in General-Science Class

The organization of the new science courses for noncollege-preparatory students in Trenton has been discussed earlier (pages 47–50). The first unit in Science II in Central High School is called "Natural Resources, including Energy Resources, and How They Are Used." One aim is to relate what is learned as closely as possible to the problems of Trenton and the people living in Trenton. Guide sheets are prepared for students showing how what has been learned by reading and laboratory work applies to the community. Discussions are designed to stimulate the same kind of thinking.

One guide sheet starts with a discussion of why people live in Trenton and suggests listing (1) the products Trenton sends out into the world, (2) the industries that produce these products, and (3) the raw materials on which the life of the city depends.

Then follows a series of questions for study and discussion such as: What companies in Trenton use iron and steel? In what form does iron come to Trenton? Where does it come from? How is it processed? Where do the raw materials come from? Are they found in adequate quantities in the United States? How long will they last? How do other nations rank as producers of iron and steel? Similar questions are listed for copper, aluminum, rubber, plastics, and clay.

Attention is drawn to the fact that Trenton needs energy as well as raw materials. Questions are asked about the various kinds of energy, their sources, how they are distributed and used, what their advantages are—questions paralleling those in many textbooks but with special reference to Trenton and its relations to the rest of the United States and to the world. Originally, one section in this guide sheet was devoted to electricity. In later years a separate unit was devoted to study of electricity.

The last part of the guide sheet deals with the over-all neces-

sity for flow of materials and energy from sources to consumers if the unsatisfied wants of our 144 million people, as well as those of the rest of the world, are to be met.

The science program at Trenton was influenced in many ways by the war. As happened in all the other schools, special emphasis was given to the physical sciences. New courses were offered, some dealing with materials, energy, and machines. No large blocks of subject matter were omitted from, or inserted in, the regular courses. However, there were changes in emphasis. In chemistry, for example, more time than usual was devoted to war gases, incendiary bombs, magnesium, high-octane gasoline, and explosives. In addition to teaching such topics in terms of structural formulas, effects, and preventive measures, effort was made to lead discussion on to questions of the social significance of our inventions—whether the best we can do is to live in a world where our best efforts are devoted to using our resources purely for destructive ends.

Social and Scientific Problems Studied Together at Cranbrook School

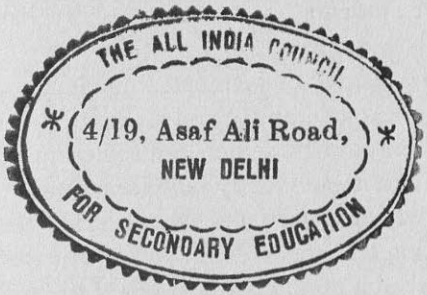
The pamphlet *You and the Wealth of the World* was prepared for the integrated chemistry-economics course given at Cranbrook (pages 64–66). The introduction describes this pamphlet as one in a series designed to present "the ascertainable facts, the most reliable estimates, and the most authoritative opinions about the material and energy at our disposal and the present and possible methods of producing, distributing, and consuming them."

The course as a whole attempted to give students basic understanding of the properties of the metals and nonmetals we use in modern industry; their distribution over the earth's surface in the atmosphere, hydrosphere, and lithosphere; and the problems of extraction, refinement, manufacture, and distribution connected with their use. These problems require for their solution not only scientific facts but an understanding of social

relationships as well. The teacher of chemistry and the teacher of economics planned and taught together. They laid special emphasis on the industrial and social problems of Detroit and the Middle West.

Colorado State College, Olney High School, and Susan Dorsey High School

Courses in the secondary school of Colorado State College of Education in Greeley, Olney High School in Philadelphia, and Susan Miller Dorsey High School in Los Angeles have been described in previous sections (pages 67–68, 60–61, and 50–52).



CHAPTER 8. Man's Place in the Universe

Science courses traditionally have included some material on the nature of the universe. Most junior-high-school science courses contain units on the earth and its relation to the solar system. In senior-high-school science courses, the nature of matter and the nature and origin of energy are studied. Although such studies have direct reference to concepts of the nature of the universe, neither students nor teachers usually have these concepts consciously in mind.

It is a matter of common knowledge that conceptions of the universe are complexly and inextricably related to bases for conduct. Emotional conflicts are sometimes precipitated when people find their previously held ideas about the universe challenged by newly learned facts. Members of the Bureau staff and cooperating teachers were in agreement that to help young people resolve such conflicts is a special responsibility of science teachers, for science investigation and instruction deal intimately with the nature of things.

DESCRIPTION OF THE AREA

As a result of workshop discussions, suggestions for teaching about the extent of the universe were prepared and mimeographed.[1] A list of generalizations was drawn up, based on a summary of the major scientific findings in the area and on the conviction that knowledge of facts, knowledge of methods, and knowledge of the history of thought all are involved in the de-

[1] Elsa Marie Meder. *Developing a Scientific World-Picture.* Mimeographed. Bureau of Educational Research in Science, Teachers College, Columbia University, New York, 1940.

velopment of a scientific world-picture. The generalizations included the following.

1) The earth is the astronomical body from which man views the other celestial objects; it is a part of the solar system.

2) The solar system includes nine known planets, their satellites, planetoids, comets, and meteors; all these bodies revolve around the sun.

3) The sun is a gaseous body whose diameter is about 110 times that of the earth. It constantly radiates enormous amounts of energy, of which the earth receives a small fraction.

4) The sun is one of billions of stars in our galaxy, the only one from which our distance can be conveniently expressed in miles. For other stellar distances, the unit used is the light-year.

5) The stars are not unchanging but seem to undergo a life-cycle, which is evident to us by the differences in brightness of stars whose distances and densities are known. The sun appears to be somewhere between maximum brightness and extinction.

6) The galaxy of which our sun is a member (not the central star, however) has been found to be a disk with a short diameter measured in thousands of light-years and a long diameter measured in tens of thousands of light-years.

7) There are uncounted galaxies. Study of those distant more than 100 million light-years has shown them to be grouped by the hundreds into supergalaxies.

8) Despite the vast numbers of heavenly bodies, the universe is comparatively empty. Interstellar distances are enormous; intergalactic distances are virtually incomprehensible.

9) The kind of matter observed when studying other astronomical bodies does not appear to differ significantly from that which is known on earth.

10) The methods of science are those of systematic, critical examination and are opposed to blind reliance on authority.

11) Scientific methods include the formation of generalizations from hypotheses which were set up to explain observed phenomena or were deduced from previous knowledge, and

which were tested, revised, and confirmed in the light of accumulated data.

12) Man has always attempted to explain and control the universe in which he finds himself. Many of his theories have been in accord with the observations that could be made.

13) Scientists have not been content with the explanations of the universe that they inherited, but they have continued to study its nature and extent. We still know only part of the explanation.

These generalizations defined an area of study which was used in nine cooperating schools. It seemed important, however, that not only the teachers, but the students as well, should be clearly aware that the subject matter they were studying had implications for their own fundamental thinking. Consequently, an imaginary incident involving high-school boys was written in dramatic form and used to introduce the area of study. The incident is quoted here.

A Midnight Conversation

On an overnight hike this summer, four boys spread their blankets on the ground and lay looking at the stars and talking. A part of their conversation is given here.

George: Gosh, you can see a lot of stars tonight!

Henry: There must be millions of them.

Jim: And every one of them is as big as the sun.

Henry: What makes you think that?

George (speaking at the same time as Henry): No, they're bigger than the sun—most of them, I mean. The sun's just a medium-size star and not very bright, either, compared with some of those up there.

Jim: I wonder whether any of them have planets? Just think—millions of stars, and if each of them had eight planets like the sun. . . .

George: Nine.

JIM: Nine, then, you old scientist. Anyway, there might be millions of worlds like ours. Gee, we don't seem very important, do we?

GEORGE: We're not. Mighty unimportant, if you ask me.

HENRY: I don't agree with you there.

GEORGE: Well, look: how many people are there on earth, anyway?

HENRY: About a billion, I guess.

GEORGE: And how many animals?

HENRY: Oh, billions, especially if you count all the microscopic ones.

GEORGE: So you're just one living thing among so many other living things you can't even count them. How important does that make you?

HENRY: I don't appear so, I admit. But human life is worth an awful lot, just the same.

GEORGE: Oh, I agree with you that it's fun to be alive, and I don't want to die just yet. But heck, it doesn't mean anything! Us here—and up there, hundreds of thousands of light-years away, millions of suns. What good are we anyway? Why, I heard my father say that if something should happen to the sun so that the whole solar system disappeared, it wouldn't make any difference to the universe.

HENRY: But it would. Look, you've left God out of all this. He made the earth, and made us, too, and even if we can't see what His purpose is, He has one.

GEORGE: I don't see how you can think that. There are so many stars, and the universe is so enormous, that I just don't see any point in our being here.

HENRY: Sure, the universe is enormous, and everybody feels that way sometimes. You know David said, "When I consider thy heavens, O Lord, the work of thy fingers, the moon and the stars, which thou hast ordained, what is man that thou art mindful of him, and the son of man, that thou visitest him?"

JIM: That's right. Say, you know the Bible, don't you?

HENRY: There's something else in it that sort of fits in here. That's the place where it says that. . . .

BOB (speaking for the first time): Aw, why don't you shut up? Or else talk about something worth talking about!

In addition a pamphlet was prepared as reading material for students.[2] This pamphlet presented in simple and interesting form the facts and generalizations previously mentioned. It included discussion of the methods by which man has learned about the earth, the solar system, and the other bodies in our universe. The way our ideas about the world have changed through the centuries as new facts have been discovered was pointed out as well as the incompleteness of our present knowledge.

RESULTS OF TEACHING AND LEARNING

Both the teachers who worked in this area and the students in their classes felt that the study was important and valuable. That the students felt this way was attested by the fact that discussion was carried over into other classes than science. In two schools, students brought the introductory incident and pamphlet into young people's church groups for study and discussion. One of the cooperating teachers let his students read the introductory incident but did not follow it up with study in the area. Nearly four months later, he asked his students to state what area of study they felt would be most important for them to investigate further; the one response that was repeated over and over again was "A Midnight Conversation."

In some of the schools, a direct effort was made to find out whether students' increased information about the extent of the universe actually did result in changed opinions about man's

[2] Samuel Ralph Powers and Elsa Marie Meder. *The Spangled Heavens.* Multigraphed. Bureau of Educational Research in Science, Teachers College, Columbia University, New York, 1941.

place in it. A member of the Bureau staff developed some valid and reliable pre- and post-tests of knowledge and of opinion, and these were administered to students who were working in class in this area and to control groups. The results of this testing program are reported elsewhere.[3] They showed that increase of information did influence students' attitudes in the area investigated.

Astronomical and Philosophical Study in a Physics Class

One of the classes that spent some time investigating the area defined in the foregoing pages was a college-preparatory physics class in Denby High School, Detroit. After the students had read and discussed "A Midnight Conversation," they spent about a week considering astronomical subject matter. Then the Detroit newspapers carried reports of some lectures on astronomy and on the relations between science and religion. When certain students brought these reports to class, they and the other students became much interested in discussing the effects of expanding scientific knowledge on religious beliefs. When the discussion started, the teacher had the feeling that his contribution would constitute a defense of science, but he soon found that his role was that of a defender of religion. Most of the students declared themselves atheists. Only about one-third of the class members attended as many as two religious services a month.

The next two days were spent in an effort by the teacher to lead the students to see that science and religion are both important aspects of life: science deals with observational data, and religion deals with questions of value. When he mentioned that questions of value could be investigated by methods other than those commonly called *scientific*, the class demanded more specific information concerning these methods. On the teacher's advice, the students sought this information from one of the

[3] Elsa Marie Meder. *Youth Considers the Heavens*. King's Crown Press, New York, 1942.

school staff whose college major had been philosophy. This man visited the class and introduced them to the story of philosophy. This visit set off a series of reports, one a week for the rest of the semester, on the great philosophers. The students who gave these reports tried, sometimes unsuccessfully, to concentrate on the philosophers' ideas of the values of life.

The teacher had no doubt as to the importance of this study. Just where in the curriculum it should be offered was, he felt, a matter of some question. "I hate to take time away from physics for a college-preparatory class, although I would again . . . I was continually impressed with the tremendous lack of knowledge of the students about Christianity, and how easily they seemed to fall in with any half-baked philosophical idea they had heard."

GENERAL CONCLUSIONS

Two general conclusions may be drawn from the experience of those teachers who made the direct attempt described here to help their students see scientific information about the universe in relation to their own frameworks of belief. One conclusion is that information bearing upon an understanding of the universe should certainly be included in the curriculum at a time when young people are seriously considering questions of a philosophical nature. They need all the help that can be given in building for themselves philosophies of living that will be in line with the facts, serviceable, and emotionally satisfying. The second conclusion is a corollary of this. Teachers must themselves have the opportunity to acquire a background of appropriate scientific and philosophical knowledge and to achieve their own orientation. If their own thinking is confused, they cannot be expected to choose facts wisely or present them fairly to their students.

CHAPTER 9. Work through Curriculum Centers

Cleveland public schools, during the period 1939–1942, operated on a plan according to which certain schools were designated as *curriculum centers* in various subjects.

Cooperative work with the Bureau took place in three senior-high schools that had been named as curriculum centers in science. In these three schools new organizations of material, new units and courses, and new evaluation devices were tried out. Certain members of these schools participated in Bureau workshops and passed on to other Cleveland schools material prepared by the Bureau staff. In turn, they brought the curricular and evaluation materials developed in the Cleveland schools to the attention of teachers in all the cooperating schools.

In 1941–1942 the following statements were formulated with respect to the work of the Science Curriculum Centers.

1) We were not attempting to set the world of science education afire with novel, sweeping, and unusual reforms!

2) We recognized the fact that good work had been and was being done in science education in the senior-high schools of Cleveland.

3) We had not been assigned the task of writing a new course of study. Our task was that of supplementing present outlines with new materials. From such activities new courses of study might come into existence.

4) Materials were to be selected and organized so as to be usable by the *average child* and the *average teacher.*

5) The work included experimentation with new teaching techniques and laboratory procedures.

6) The attack upon problems of personal and social significance was direct and in terms of meeting the needs of students.

Science teachers in Cleveland, especially those in the Science Curriculum Centers, worked out a series of curriculum *departures* during the three years of cooperation with the Bureau. Each departure gave specific objectives for teachers and students, detailed suggestions for student activities, questions for discussions, and a bibliography. Every effort was made to make these materials practical and up to date. For example, a departure called "Better Teeth for Better Health," prepared in 1942, gave the Army standards with respect to dentition. One teacher using this departure arranged a dental examination for all her biology students. Thirty of 49 students showed need for fillings in 125 teeth, 7 showed need for extraction of 12 teeth. As study in the unit proceeded, every effort was made to encourage students to have the needed corrective work done.

Following is a list of the departures prepared during 1940–1942.

Biological Science

HEALTH

Use of "Scientific Method" in Evaluating Health Advertising, 1940

How May I Wisely Choose the Toilet Preparations I Need, 1942

The Decease of John Smith (an exercise in critical thinking), 1940

Our Common Enemy—the Cold, 1940

Tuberculosis, a Problem of Youth in the Community, 1941

Adequate Nutrition, 1941

The Vitamins—Eating to Live, 1940

Better Teeth for Better Health, 1942

Modern Techniques in First Aid, 1940

How to Build and Maintain a Healthy Heart, 1940
You and Athletics, 1942
The Impact of Environment on Human Welfare, 1940
Suggested Science Materials for Use on Temperance Day, 1940
The Basis of Personal Appearance, 1941
Chemical Coordinators of the Body, 1941
Conditioning Human Behavior, 1941
How the Forces of Daily Life Affect Mental Health, 1941
Biological Aspects of Adolescence, 1940
Genetics, 1940

GENERAL

Getting a Job as a Bug Specialist, 1940. (This unit was designed to illustrate how the teacher can make vocational emphasis in biology.)
Spring Gardening Activities, 1941
Fall Gardening Activities, 1941
Feeding Our Winter Birds, 1941
Window Gardens, 1941
Daily Use of the School Conservatory, 1942
Care of Trees, 1942
Better Lawns and Gardens, 1940
Wider Use of Metropolitan Parks, 1940
Suggested Materials for Use in Teaching Conservation, 1940

Physical Science

SENIOR SCIENCE

Housing from the Standpoint of Building Materials, 1941
The Hobby of Photography, 1941
Greater Safety in Everyday Life, 1941
Synthetic Textiles, 1941
Man-Made Climate, 1941
Does Man Use Science to His Advantage? 1941

Fire Prevention in Peace and War, 1942
Metals for Airplanes, 1942

PHYSICS

Modern Interior Lighting, 1941
Modern Uses of X-rays, 1941
Polarized Light in Modern Living, 1941
The Internal-Combustion Engine Speeds Up Civilization, 1941
Refrigeration for Health and Comfort, 1941
Exploring Our Fluid Frontiers, 1941
Meteorology, 1941
Air-Conditioning, 1941
A Scientific View of the Universe, 1941
Better Use and Control of the Common Sounds, 1942
Keeping Better Time, 1942
The Origin of Weights and Measures, 1942
Lives and Discoveries of Great Physicists, 1942

CHEMISTRY

Chemistry of the Body, 1941
Civilian Air-Raid Defense, 1942
Consumer Food Chemistry, 1942
Getting the Most Out of Our Fuels by Smoke Control, 1942
How We May Protect Ourselves in Chemical Warfare, 1942
How Chemurgy Is Related to Conservation, 1942
George Washington Carver, 1942

In 1942–1943 drastic modifications in the physical-science program led to development of new courses in preflight aeronautics and pre-induction radio work.

SECTION IV. The Significance of the Project

CHAPTER 10. Summary and Evaluation

The preceding pages have presented a report of developments in seventeen secondary schools in the United States over a three-year period, 1940–1943. During that time these schools were carrying on a cooperative project with the Bureau of Educational Research in Science, the purpose being to improve education in the several communities through improvement of science teaching. They were not demonstration schools. They were like most good schools in that the administrators and teachers in each were interested in doing a better job for their own students and their own community. The reports of what they accomplished should be stimulating to the many other schools that have similar goals and are meeting the same kinds of problems.

The first step in the project was to enlist the cooperation of the administrators in the selected schools. Each administrator named one science teacher to act as a representative of the school. These cooperating teachers were given opportunity and encouragement to work with other teachers, in their own schools and in other schools, and to assist in planning curricular changes. They attended workshops and conferences, distributed materials developed in the Bureau to other teachers in their schools, and carried reports to the Bureau of what was being done in the schools. The staff of the Bureau, resident in New York, gave assistance by arranging and participating in New York and in the schools and by helping to prepare and distribute materials for teaching and evaluation.

In the summer workshops and in their schools through the year, the cooperating teachers enlarged their own backgrounds by three interrelated kinds of studies: study of the resources and

people of their communities; study of the needs and problems of young people, especially those in their own classes; and study of the problems that individuals and the nation face today. With the results of these studies in mind, they modified their own teaching and worked with other teachers on curricular changes in the schools as a whole. While the cooperating teachers were all science teachers, the interest in many schools spread to other departments.

RELATION OF THIS PROJECT TO DEVELOPMENT OF SCIENCE EDUCATION

Obviously this project does not stand alone. It takes its place as one in a long line of cumulative achievements in the field of science education and of education in general.

An early decisive turn in modern thinking about education was given by publication of *The Cardinal Principles of Education*,[1] which was followed by reports and recommendations for implementing these "cardinal principles" in many fields of specialization. One of these reports, *Reorganization of Science in Secondary Schools*,[2] stressed for science education the idea of choosing what is to be taught in terms of what it can contribute to more successful living. The writers of this bulletin paid respect to the traditional fields of science as organizing centers, but they also recommended transcending the boundaries of these fields for beginners whose interests are seldom limited to one field of knowledge. This report stimulated thought, discussion, and experiments in teaching, which led to changes in teaching methods. The Thirty-first Yearbook of the National Society for the Study of Education drew together accounts of many of these

[1] *The Cardinal Principles of Education.* Bureau of Education, Bulletin No. 35, Washington, 1918.

[2] *Reorganization of Science in Secondary Schools.* Bureau of Education, Bulletin No. 26, Washington, 1929.

experiments and changes and formulated statements of trends.[3] This publication recommended that teaching be planned not in terms of a series of details but in terms of great scientific generalizations that give meaning to many details.

Parallel developments in the field of psychology have, through the past two or three decades, laid stress on the differences among individuals. At the same time, there has been a change in our high-school population, which today consists more nearly of all the children of all the people than of the few who plan to continue their academic training into college. As a result of these and other influences, there has been all over the country emphasis on education for life, an emphasis suggested some years ago by John Dewey and other educational philosophers but only slowly reaching into secondary schools. In the field of science education, this emphasis was given expression in *Science in General Education*, a report of the Committee on the Function of Science in General Education, Commission on Secondary School Curriculum, Progressive Education Association.[4] The Forty-sixth Yearbook of the National Society for the Study of Education carries further the emphasis on general education and recommends organizing teaching in terms of important problems to be solved, drawing ideas relevant to their solution from any fields of knowledge, irrespective of traditional boundary lines.[5] This report recognizes the need for a continuous program of science study, closely related to life-experiences.

It is always difficult to forecast the future, yet it seems certain that progress will continue along lines of development which have proved fruitful in the past. Materials and methods of teach-

[3] National Society for the Study of Education. Thirty-first Yearbook, Part I, *A Program for Science Teaching*. Public School Publishing Co., Bloomington, Ill., 1932 (now distributed by University of Chicago Press).

[4] Progressive Education Association. *Science in General Education*. D. Appleton-Century Co., New York, 1937.

[5] National Society for the Study of Education. Forty-sixth Yearbook, Part I, *Science Education in American Schools*. University of Chicago Press, 1947.

ing will undoubtedly be more closely adapted to individual communities, individual classes, and individual boys and girls. If so, there can be no standardized objectives or standardized patterns of curricular organization. To those who may plead college domination as an excuse for standardization, the answer is twofold: (1) college administrators are themselves taking leadership in many places in adapting college offerings and requirements to changing times; (2) most high-school students will not go to college, at least not to a college with a traditional program.

The future should bring not one new pattern of curricular organization but many new patterns, each continuously shifting as conditions of living shift. The concept of an ever-changing equilibrium among many elements is fundamental in modern science. It should be relatively easy for teachers of science to recognize the same concept in education—changing communities, changing young people, changing knowledge, and changing curricular patterns shaped to fit them. It is to be expected that science teachers will meet the challenge of continually developing new materials and of reworking the old in terms of closer, more vital relationship to the problems of the people who are learning.

The project with which this report is concerned takes its place, then, as an illustration of how teachers who know their communities and who are thinking of the meaning of science for improving living have sought to put their philosophy of education into practice in specific situations. The account of what a few teachers did in developing teaching procedures adapted to their own situations indicates the kinds of changes other teachers may find valuable in other situations.

CHANGES BROUGHT ABOUT

Some estimation of the significance of the project can be made from consideration of changes brought about in the curricula of the various schools, changes in the young people so far as we can identify them, and changes in the teachers themselves.

Curricular Changes

Generally speaking, curricular changes were of three kinds: (1) introduction of new interdepartmental courses; (2) development of new courses in science; (3) change of emphases in already existing courses.

Some form of interdepartmental cooperation was attempted in nine of the seventeen schools. This ranged from a loose correlation between chemistry and American history in one school to a reorganization of all the subjects in one grade in two others. Time for planning was essential to the success of these courses. Provision of this time proved the greatest administrative problem, although it was not unsurmountable. Science and social studies were correlated in three schools, science and English in three others and home nursing and biology in another. Results were most successful when teachers of the two subjects involved were present during the class periods. Administratively this was made possible by scheduling classes in adjacent periods and adjacent rooms, thus allowing flexibility in planning field trips, laboratory work, group discussions, and use of visual aids.

All but one of the interdepartmental courses centered in study of the community. This focus reflected the interest of the cooperating teachers in their own study of their communities and their belief that the community presents vital opportunities for study by young people as well as adults. The interdepartmental organization represented an effort to bring several points of view to bear on community problems rather than leaving young people to piece together alone ideas derived from a number of isolated courses.

A second kind of curricular change was drastic modification within the science program itself. In five schools new science courses were introduced. Teachers in general were more likely to feel that they had not done as well in the past by the students who would end their formal education with high school as by the college-preparatory students. The new courses were pri-

marily designed for groups of students with certain characteristics in common, for example, biology or physical science for those whose goals were other than college, or an individualized course in chemistry for the scholastically above average students.

The third curricular change was the reorganization of already existing courses, either by modification of old units or by introduction of new ones. In one large school system, teachers were encouraged to plan teaching materials about any specific problems or interests that grew out of the more general material in the courses of study.

The most common change in biology courses in all the cooperating schools was the inclusion of material on human development and growth. In one school, this inclusion meant a new organization of one semester's work; in another, concepts of human development permeated the work of the whole year; in still others, short units of study specifically related to problems of adolescence were introduced. Similarly, material concerned with the interrelations of living things was incorporated in a number of biology courses, often as a new approach to the study of conservation.

In the physical-science courses the concept of the flow of materials and energy through a community provided a new framework for much that had been taught before in a more formal context. A number of schools introduced material about the nature of the physical universe into physics and physical-science courses.

Changes in Students

The original plans for the project included suggestions for finding and measuring at least some of the changes occurring in children and in communities as a result of the curricular changes in the schools. The war with its attendant pressures on the curriculum and changes in personnel made complete evaluation impossible. However, the first part of an evaluation program was carried out.

Each cooperating teacher identified and described changes

that seemed desirable and directed his teaching toward those goals. The teachers stressed not one kind of change but many: increase of knowledge, development of attitudes of open-mindedness and cooperation, better understanding and appreciation of the nature of the universe and of human nature, and behavior based on knowledge and reflection. All the evidence available from observation and controlled studies indicates that we do tend to bring about through teaching the changes for which we teach. The preliminary definition of goals, therefore, and the shaping of teaching in terms of them foreshadow accomplishment, to some extent at least. Children develop through their experiences. When we give them certain experiences, set them certain problems, and help them to see certain relationships, we give direction to their thinking and learning. How far they will go and the many ramifications of their learning can be determined only in small part, and even this determination requires laborious study and the use of carefully devised techniques and instruments. The general area of people's thinking is determined by their experiences. When experiences are planned, as the curricular changes herein described were planned, in terms of solving personal and community problems, it is reasonable to assume that better command of these problems will result than if the curricular changes had been made in terms of other goals.

Each cooperating teacher, in addition to defining and describing expected changes in his students, drew up plans for evaluation designed to find not only the direction but the extent to which certain changes occurred. Some of these plans involved collecting subjective judgments from children, parents, other teachers, and members of the school or community who came in contact with the children. Some involved watching behavior and recording questions asked.

Time was given in each workshop for study of evaluation techniques, and all the teachers prepared and used a variety of testing devices. Batteries of tests were prepared in some fields by staff members, and results were gathered and compared from a number of schools. Results of all these kinds of evaluation consistently

showed the kinds of improvement in thinking, feeling, and acting that had been envisaged.

Three careful studies were made in an effort to go beyond this comparatively informal kind of evaluation. One was in the Bronx High School of Science, where measurements were made in experimental and control groups. The results, which have been discussed earlier, showed that desirable improvements in attitudes were made in the experimental group, without lessened mastery of subject matter.

A second research was in the study of the physical universe. Comparable groups in a number of schools were taught in different ways. Carefully devised pre- and post-tests were given to find (1) how children's knowledge of the parts and the extent of the universe changed as a result of their learning experiences, and (2) whether their opinions about man's place in the universe also changed. The results give a firmer basis to the belief that teaching can and does modify the way people think and feel as well as what they know.

The third study was carried on at Susan Dorsey High School. One hundred fifteen students from an experimental chemistry course were matched with the same number from other chemistry courses in the same school. The pairs showed comparable gains in mastery of subject matter. Those from the experimental classes showed superior ability to use scientific methods in attacking problems, thus adding to our knowledge of transfer of learning from one situation to another.

Changes in Teachers

We have looked at the schools and have found that curricular changes were made, within the framework of regular schools, by teachers within those schools. We have looked at the young people reached by these curricular changes and have found that they did develop greater understanding of, and ability to deal with, personal and social problems. What of the teachers? What did these three years mean for them?

There is no doubt that the teachers worked harder during

these years than ever before. They learned and applied new techniques for studying communities and children. They explored new fields of science and ventured out into other fields than science where they felt less at home and somewhat frustrated by their lack of knowledge. They filled in gaps in their own backgrounds. They planned and gathered new teaching materials. They learned new evaluation techniques and constructed new instruments of evaluation. They gave up their summers to work in workshops. They spent hours and days through the year in conferences. They did all this with an enthusiasm which could only mean deep professional interest and satisfaction. The sense of participation in vital enterprises was widespread and lasting.

As one looks at these schools and what happened to them through this three-year period, he is struck by the leadership, often unsuspected, that was uncovered. The teachers involved were good teachers, just the kind of good teachers to be found in innumerable other schools. They were challenged to look at their communities and see the problems existing there, and to find out more about the interests and problems of the adolescents they were teaching. When they did this they saw ways of using their specialized training which they had never seen before. First, they became better informed citizens themselves. Then they became people in the school who were doing important and exciting things educationally. They saw their scientific knowledge and ways of working as something vitally related to making life richer for individuals and more successful for the community as a whole. The fact that these teachers caught this vision and were able to put it into practice, however incompletely, means that other teachers can do likewise.

Tradition, departmentalized thinking, and administrative inflexibility were as powerful in the cooperating schools as in others. Yet in each something new was done, some attempt was made to bridge the gap between knowledge and action, and it was done by the regular teachers in the school.

A majority of the men in the group and some of the women

entered the armed services or some of the war agencies before the end of the three-year period. The Bureau of Educational Research in Science can claim no credit for the intelligence and fundamental training that contributed to their fine record through the war. The habits of thinking of their specialized training in terms of its usefulness in real situations, however, had been fostered by the cooperative work and, undoubtedly, contributed to their adaptability in new situations. Many of them did distinguished work in bringing to the problems of war the technical skills in science and education which they had developed in relation to problems of peace.

Perhaps the following summary made by one of the cooperating teachers four years after the project formally closed states, as clearly as it is possible to state, what the project meant to the teachers.

"1) The experiences were cumulative in their effect. It is only as one gets away from them and thinks about them and lives with the ideas they developed that he sees their significance. No real evaluation could have been made earlier.

"2) The whole program emphasized the responsibility we as individual teachers in our own classrooms carry for effective improvement of science teaching. Workshops and conferences devoted to planning what to do with our own students were more valuable than any amount of restating again and again the philosophy and objectives leaders in education have already formulated.

"3) As individuals, we developed tolerance and respect for what other people in other situations do. We became interested in situations other than our own. We became keenly conscious that there is no one best way. We went further and developed a feeling of oneness with many other science teachers.

"4) In dealing with other teachers now and with prospective teachers we have more confidence in our ability to suggest and to guide. We know these things can be done because we have seen them done."

APPENDIX A. The Cooperating Schools and Teachers

The following brief descriptions of the schools that cooperated with the Bureau of Educational Research in Science are intended to give the reader a general understanding of the schools, the kinds of students they included and the kinds of communities in which they were located. The names of the cooperating teachers are also given, although in every case other teachers and administrators contributed to the planning and carrying out of the project.

PUBLIC SCHOOLS

Cincinnati, Ohio

The city of Cincinnati is located in the valley of the Ohio River and serves as the center for the mining, agriculture, and associated industries of a rich country. "Smog" and the periodic floods of the Ohio are problems of pressing importance, directly and indirectly, to all the citizens. There is a large Negro population, which is served by the same schools as the white population. The families of north European extraction have contributed richly to the cultural life of the city, especially to the development of groups interested in musical performance and appreciation.

Active cooperation with the Bureau of Educational Research in Science was terminated after one year when the cooperating teacher joined the resident staff in New York. During that year a number of schools and a number of teachers of science and social studies contributed to the Bureau project.

Cooperating teacher: RICHARD LAMPKIN

Cleveland, Ohio

The population trends in Cleveland, reflected in the city's schools, have been such as to bring clearly to the attention of teachers and school administrators alike the importance of broadening the high-school program to meet the needs of students of widely varying backgrounds and potentialities. Between 1939 and 1943 efforts in this direction were made through "curriculum centers," which were high schools designated as centers for the development of teaching materials related to problems of personal and social significance in various subject-matter fields. Materials prepared by the teachers in the curriculum centers were distributed to all the other secondary schools in the city. As another means of broadening educational offerings, the Cleveland schools developed an unusually extensive radio program. Broad areas of human activity were emphasized by means of weekly broadcasts to the classrooms.

Although a large number of teachers from Cleveland high schools participated directly in the work of the cooperative project, the city supervisor of secondary-school science was officially designated as Cleveland's cooperating teacher.

Cooperating teacher: ARTHUR O. BAKER

Des Moines, Iowa

In Des Moines, as in Cleveland, the administrative policy was that of participation in educational projects by the school system as a whole rather than by individual units. Consequently, a number of junior- and senior-high schools worked with the Bureau.

Des Moines is situated in an agricultural state, but other industries, especially mining, are of importance. The students and their families represent a cross section of American life so far as occupation, financial status, and intellectual ability are concerned. There are a number of colleges in and near Des Moines, which means that a high proportion of students have opportunity for post-high-school education.

One outstanding feature of Des Moines has been the close cooperation between schools and homes. For years the school system has been noted for its progressive administration and for the encouragement given to experimentation and development of new ideas. During the three years of the Bureau project, the schools participated in a number of other projects of local and national interest. In 1940 and 1941 the schools developed closer integration with the community as a whole by their participation and, in some instances, leadership in making a comprehensive survey of community resources which might be used for educational purposes, thereby making the public schools an effective agency for community development and betterment.

Cooperating teachers: GODFREY SIVERSON, WILBUR YOUNT

Detroit, Michigan

The cooperating school in Detroit, Edwin Denby High School, is situated in a residential district in which the families are economically above the average for the city. The students are all white, mostly second- and third-generation Americans stemming from northern Europe. About 7 percent of the 4000 students go to college after graduation. Many have part-time jobs while still attending school. Denby is a four-year high school, offering college-preparatory, general, and commercial curricula.

Detroit grew and changed rapidly through the late 1930's, the rapid growth bringing many problems of housing, transportation, education, "race" misunderstandings, employment, and health. The administration of Denby and certain of the faculty were acutely aware of these problems and their significance for their students and were interested in how best to modify teaching so as to give adequate consideration to these important areas while still preserving the demonstrated values of the existing curricula.

Cooperating teacher: RAYMOND AGREN

Glens Falls, New York

Glens Falls High School is a senior-high school of approximately 750 students. About a fourth of the graduates of the school go to college, and about 75 percent prepare to take the New York State Regents' examinations. The curriculum is a typical departmentalized secondary-school curriculum. There is an extensive extracurricular program in addition to the regular school offerings. About 60 percent of the students remain in the community after graduation.

The city of Glens Falls has a population of about 18,000 and is located on the bank of the Hudson River in northern New York. At one time the city was one of the wealthiest cities per capita in the United States, because of its natural resources of lumber, water, limestone, iron, and game. The character of the industries in the city and, consequently, the ones into which students will go has changed greatly as natural resources have been exhausted or have been depleted to the point where conservation becomes important. It remains, however, an industrial city because of its supply of water power.

Cooperating teacher: ROBERT KING

Hammond, Indiana

The George Rogers Clark High School in Hammond, Indiana, consists of the upper four grades of a 12-year school and includes between 700 and 800 students. The school is located near oil refineries, steel mills, metal refineries, a soap factory, and a corn products company. The nearness of these industries to the residential district served by the school determines in large measure the character of the student body. The majority are children of skilled and unskilled laborers in the industries of the community. These students do not go to college but find jobs or marry upon leaving school. There is a smaller group of students whose fathers are employed as chemists and executives in the local industries. In general, members of this group continue their education

after high-school graduation. These students have made excellent records in comprehensive examinations and in college, a fact of which the school is justifiably proud.

During the period of cooperation with the Bureau, the problem confronting the administrators and teachers of George Rogers Clark High School was that of doing three things well: to provide some students with the training basic to further formal education, to give all students a broad general education, and to prepare a large number of students for their immediate future as workers and home-makers.

Cooperating teacher: VEVA MCATEE

Indianapolis, Indiana

The Arsenal Technical Schools include an academic high school and a number of vocational schools. The student population averages about 7000. Because of its size, Arsenal Technical can offer a wide variety of courses. At the start of the cooperative project, science courses were being offered in the specialized departments of botany, zoology, chemistry, and physics. Courses in agriculture, physiography, astronomy, and physiology were given in departments not officially named as science departments. Teachers of all these classes participated in the Bureau project.

The Arsenal Technical campus is spacious, and includes gardens, agricultural plots, and an extensive Nature Preserve. The shops are numerous and well equipped. The several schools are interrelated: academic students take certain shop courses as electives; vocational students take such courses as English and science in the academic high school. The counseling service of the schools endeavors to help children select studies that are appropriate in terms of their interests and abilities. A coordinator keeps in touch with graduates who go into industry. The practical concern of the teachers has largely been with the preparation for industry of 75 to 80 percent of the students and with the preparation for college of the other 20 to 25 percent.

The students represent a cross section of the white population of the entire city and vary, as does the adult population, in economic, intellectual, and cultural levels.

Cooperating teacher: CHARLOTTE L. GRANT

Los Angeles, California

The Susan Miller Dorsey High School in Los Angeles was founded in 1937. It entered the cooperative project of the Bureau in 1941. By that time it had a student body numbering 2100.

The school is located in one of the newer sections of the city. The houses are modern, and the residents are economically secure. Even during the 1930's, unemployment was slight. The school buildings are attractive and modern, planned for efficiency and adapted to the southern California climate.

The majority of the students of Dorsey High School are of European extraction, although before the war the number of Japanese-Americans was increasing rapidly. Many of the students plan to enter college, and the school maintains close and informal relations with members of the faculties of the University of California at Los Angeles and the University of Southern California.

Cooperating teacher: WARREN P. EVEROTE

New York, New York

The Bronx High School of Science in New York, opened in 1938, was in many ways the most unusual school included in the study. It is a public school designed for boys who show interest and ability in the field of science. Final selection of students depends upon achievement in an entrance examination. The result is a student body of around 2000 of definitely superior ability. For example, the average reading age of the class entering the ninth grade in 1940 was 16.6 years.

A preponderance of the boys come from middle-class homes in the section immediately surrounding the school. The economic status of the homes is in most cases adequate, and an un-

usually large percentage of the parents are professional people. With few exceptions the boys intend to go to college. The students' interest in science is not considered indicative of their future vocational interests, but the school deliberately attempts to capitalize on their interest in science for the purpose of general education.

The teachers are selected for their willingness and ability to accept the challenge of providing educational opportunities for a superior and homogeneous group of students. The administration encourages the teachers to plan and carry out new educational ventures, even when these cut across traditional lines and differ from the procedures common to most large public high schools in large cities.

Cooperating teacher: THEODORE BENJAMIN

Oak Park, Illinois

Oak Park and River Forest Township High School is located in Oak Park, a well-to-do suburb of Chicago. The school population was approximately 3700 in 1942. The students are intelligent and well mannered; the building is large and well equipped; the general impression is that of a school which both students and teachers find pleasure in attending. A large percentage of the students are college preparatory. This means that a good deal of time and attention must be devoted to giving them the material thought desirable and necessary for college entrance, since this is a primary objective in the minds of both parents and students. Within the college-preparatory framework, however, there is a wide offering of courses and a great deal of attention to individual interests.

Of recent years there has been increasing interest in providing courses and materials for students who are slower than the average for the school and in broadening the background for the more academic students. One interesting point about the school as a whole is the organization of the visual-aids program. A teacher is freed from classes for one-fourth of his time and uses

this time to obtain materials, to list films and sources, and to plan programs with teachers and evaluate with their help the various films shown.

Cooperating teacher: HAROLD METCALF

Philadelphia, Pennsylvania

Olney High School is a four-year public high school located in the northern section of Philadelphia. About 4000 boys and girls are enrolled, representing a wide range so far as intelligence and cultural and financial backgrounds are concerned. In all of these aspects, however, the average for the school is above the average for the city as a whole. The academic standards at Olney are high; each year the students there win more than their proportionate share of the Philadelphia scholastic awards.

Cooperating teacher: LOUISE DREHER

Trenton, New Jersey

Central High School in Trenton had a population of about 4200 in 1941. The students probably represent about as good a cross section of an American community as is found in any of the cooperating schools. The families are of many national origins and include large Negro, Italian, and Polish groups.

Central High School is the only public senior-high school in Trenton and, hence, has the responsibility of preparing some students (approximately one-third) for college and others for industrial life. The school puts some emphasis on shopwork, but this is not primarily vocational shopwork. In some departments, courses are offered at two and, in some instances, three levels, one college preparatory, the others noncollege preparatory. The noncollege-preparatory levels are continually being modified in efforts to bring to students the material they will find of greatest use in their personal lives and in their vocations.

One interesting feature of the school's program is the Wednesday Study Day. On most Wednesdays through the year no regular classes are scheduled. Instead, students work on problems of special interest, drill on material for college-entrance ex-

aminations, go on field trips, practice for special music and dramatic programs, and do special work in shop, art, physical education, and science. This is seemingly an effective administrative device.

Cooperating teacher: J. GORDON MANZER

Winnetka, Illinois

New Trier High School is a four-year high school of about 2600, located in a suburb of Chicago. The students come from definitely superior families so far as culture, intelligence, and financial background are concerned. About 70 percent are college preparatory. Most are north European stock with only about a dozen Negroes and a few Italians in the school.

In general, there is sectioning of students in the classes according to ability, but the lines are not hard and fast. The "slow" classes at New Trier in general represent about the average for the country as a whole. However, of recent years the school has been developing a few classes for the very slow.

New Trier has a tradition of many years standing for doing pioneer work in education. It has flexibility and above-average material resources, yet has all the limitations inherent in the operation of a fairly large public school. Procedures that are demonstrated to have value in such a school in general can be adapted to other schools which do not have its opportunities for experimentation. One outstanding characteristic of New Trier is its excellent cumulative records of the intelligence scores, achievements, and health of its students.

Cooperating teachers: ARTHUR VAN DEURSEN, NORMAN CHRISTENSEN

PRIVATE SCHOOLS

Colorado State College of Education

The secondary school and lower division of the Colorado State College of Education draws its student body not only from the city of Greeley but also in approximately equal numbers

from the surrounding districts. The students probably represent a group slightly superior to the average for the country without extremes of wealth or poverty.

Instead of the usual grades, the secondary school is made up of two divisions. The 60 or so students in each division are grouped according to interests, maturity levels, and previous experiences.

The day's program centers about what are called *unified studies*. In addition, there are opportunities for work in music, art, and physical activities, and individualized instruction in basic techniques of mathematics, reading, and speech. Courses in specialized fields are offered in the upper of the two divisions of the school.

Cooperating teacher: DONALD G. DECKER

Cranbrook School for Boys

Cranbrook School for Boys is a private school of some 150 or 200 boys in the seventh through the twelfth grades. Students who live at the school far outnumber the day students. Most of the boys come from industrial centers of the Great Lakes region, and many of their fathers are active as owners and managers in the great industries of the north central region. The boys represent a favored group in terms of financial status, cultural background, and intelligence. Practically all are preparing for college.

The school is situated on a large and beautiful campus at Bloomfield Hills, near Detroit. The staff is large compared with public-school standards, the ratio of teachers to students being one to seven or eight. The men on the staff are expected to keep in close touch with the students in and out of class and to take an active part in the guidance program and in supervision during out-of-class hours. The school feels a definite responsibility for giving its students a liberal education in addition to preparing them for the colleges of their choice.

Cooperating teacher: NORMAN DOLLOFF

Fieldston Ethical Culture School

The Fieldston School is located in the Riverdale section of New York City. It is a private day school, one of the three schools of the Ethical Culture School system. The buildings and grounds are attractive and more informally arranged than in most schools. The Fieldston School, which now covers the seventh through the twelfth grades, was started as a kindergarten almost 70 years ago. At that time the impelling motive of the school was stated as a "faith in the worth, the potency, and the promise of every child's individual nature," and through the years emphasis has been consciously directed toward developing, not obliterating, individual differences. This means a tradition of flexibility and experimentation for students and teachers.

The enrollment is about 500, the numbers of boys and girls being approximately equal. With few exceptions the students go to college, and preparation for college is an integral part of the work of the school. The average intellectual level of the student body is relatively high; so also are the economic and cultural levels.

Cooperating teacher: PHILIP KOTLAR

Lincoln School of Teachers College

The Lincoln School of Teachers College in New York was a private school, from its founding interested in experimental educational procedures.[1] The classes were small, the program flexible. Its twelve grades were housed in one building and headed by a single administrator, although the upper six grades, including about 500 students, were considered to some extent as a unit.

Through the three years of the Bureau project core courses in the high school occupied a third to a half of the school day. Each was under the supervision of two or more teachers. The core courses centered chiefly in the social studies.

[1] Since this was written the policies and organization of Lincoln School have changed from those described here.

The students of Lincoln School came from homes much above the average for the country—financially and culturally. The intelligence level was high, and practically all the students were planning to attend college. There were few Negroes and Asiatics in the school, although a wide range of national extractions was represented. The children had unusually rich social opportunities at home and at school and were encouraged to think about and discuss affairs of national and world significance.

Cooperating teacher: HUBERT M. EVANS

APPENDIX B. Staff

The Bureau of Educational Research in Science
Teachers College, Columbia University

Samuel Ralph Powers, Administrative Officer

Members of the Department of the Teaching of Natural Sciences: SAMUEL RALPH POWERS, Professor and Head of the Department; HERBERT J. ARNOLD, formerly Assistant Professor; GERALD S. CRAIG, Professor; FREDERICK L. FITZPATRICK, Professor.

Advisory Committee: HERBERT E. HAWKES,* Dean of Columbia College and Professor of Mathematics, Columbia University; GEORGE B. PEGRAM, Dean of the Graduate Faculties and Professor of Physics, Columbia University; EDMUND W. SINNOTT, formerly Professor of Botany, Columbia University, now Sterling Professor of Botany and Director, Sheffield Scientific School, Yale University; HAROLD C. UREY, formerly Professor of Chemistry, Columbia University, now Distinguished Service Professor of Chemistry, University of Chicago; WILLIAM F. RUSSELL, Dean of Teachers College, Columbia University.

RESEARCH ASSOCIATES

JAMES C. ADELL (1935, 1936, 1937)
Formerly Head of Science Department, John Jay High School, Cleveland, Ohio
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* Deceased.

PAUL BLACKWOOD (1939–1941)
Formerly teacher in Hyland Park High School, Topeka, Kansas
Now Assistant Specialist in Science, U. S. Office of Education, Washington, D. C.

R. WILL BURNETT (1939–1941)
Formerly teacher in Concordia (Kansas) schools
Now Professor of Science Education, University of Illinois

GEORGE L. BUSH (1939–1940)
Formerly teacher in East High School, Cleveland, Ohio
Now Associate Professor of Chemistry, Kent State University

CLYDE M. CHRISTENSEN (June–July, 1939)
Division of Plant Pathology and Botany, Department of Agriculture, University of Minnesota

GLADYS M. COKE (1942–1943)
Formerly teacher at Sir George Williams College, Montreal

IRVING A. COWPERTHWAITE (1936–1937)
Formerly Instructor in Chemistry, Columbia University
Now with the Thompson Wire Company, Boston, Massachusetts

DONALD G. DECKER (1942–1943)
Associate Professor of Science, Colorado State College of Education, Greeley

VIVIAN EDMISTON (1941–1942)
Formerly teacher in Pullman (Washington) High School
Now Consultant on Evaluation with the Committee on Teacher Education of the Association of Colleges and Universities of New York State

HUBERT M. EVANS (1942–1943)
Formerly teacher in Lincoln School of Teachers College, Columbia University
Now Associate Professor of Natural Sciences, Teachers College, Columbia University

WARREN P. EVEROTE (1942–1943)
Formerly teacher in Susan Miller Dorsey High School, Los Angeles, California

Now Associate in Research and Production, Encyclopædia Britannica Films, Inc., Wilmette, Illinois

C. C. Furnas (1937–1938); Workshop Consultant (1939, 1943)
Formerly Associate Professor of Chemical Engineering, Yale University
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H. Bentley Glass (1936–1937)
Formerly Instructor in Zoology, Stephens College
Assistant Professor of Biology, Goucher College
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Charlotte L. Grant (September, 1941–January, 1942)
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Faith Fitch Hill (1940–1941)
Formerly teacher in Horace Mann School for Girls, New York City

Fred T. Howard (1937–1938)
Formerly high-school principal at Glidden, Iowa
Now Associate Professor of Natural Science, University of Denver

Frank C. Jean (September–December, 1935; October, 1936–July, 1937)
Formerly Professor of Biology and Head of Division of Sciences, Colorado State College of Education, Greeley
Now retired

Richard H. Lampkin (September–December, 1942)
Formerly Curriculum Assistant in Science, Cincinnati (Ohio) public schools
Now Assistant Professor of Natural Science, New Jersey State Teachers College, Montclair

Anita D. Laton (1935–1943)
Formerly Assistant Professor of Education, University of California, Berkeley

Now Professor of Health and Hygiene, San Jose State College, San Jose, California

IRVING LORGE (1939–1942)
Professor of Education, Teachers College, Columbia University
Consultant in Educational Research

OLIVER S. LOUD (1939–1943)
Formerly instructor at Sarah Lawrence College
Now Associate Professor of Physical Sciences, Antioch College

ELSA M. MEDER (1940–1944)
Formerly teacher in Plainfield (New Jersey) schools
Now Associate Editor, Houghton Mifflin Company, Boston, Massachusetts

J. WALLACE PAGE, JR. (1935–1936)
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Now Director of Education Department, Films, Inc., New York City

JOHN G. PILLEY (1936–1938)
Formerly Lecturer in Education, Bristol University, England
Now Associate Professor of Education and Chairman of the Department, Wellesley College

DUANE ROLLER (1936–1938)
Formerly Professor of Physics, University of Oklahoma, and Editor of the *American Journal of Physics*
Now Professor of Physics and Head of the Department, Wabash College

JOSEPH J. SCHWAB (1936–1937); Workshop Consultant (1939)
Formerly Instructor in Biological Sciences, University of Chicago
Now Associate Professor of the Biological Sciences in the College, Chairman of the College Natural Sciences Staff, and Examiner, University of Chicago

HOMER E. SHAW (September, 1941–March, 1942)
High School Editor, Silver Burdett Company, New York City

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Now Director of Research, Office of Chicago Operations, Atomic Energy Commission

R. M. W. TRAVERS (1940–1941)
Formerly Darwin Fellow in Eugenics, University of London
Now Associate Professor of Education and Chief, Evaluation Division, Bureau of Psychological Services, University of Michigan

EUGENE A. WATERS (1939–1940)
Formerly Assistant Professor, University School, Ohio State University
Now Professor of Education, University of Tennessee

GENE WELTFISH (February–August, 1939)
Instructor in Anthropology, Columbia University

GERTRUDE WYLIE DIEDERICH (February–August, 1936; October, 1936–June, 1937)
Formerly teacher in the Horace Mann School for Girls, New York City

LECTURERS AND WORKSHOP CONSULTANTS

Some whose names appear as research associates also served as consultants and lecturers. Their names are not repeated here.

EDNA W. BAILEY (1940)
Professor of Education, University of California, Berkeley

J. D. BERNAL (1939)
Department of Physics, Birkbeck College, University of London

HOLLIS L. CASWELL (1941, 1942, 1943)
Formerly Professor of Education, Teachers College, Columbia University
Now Associate Dean of Teachers College

HARRY G. CAYLEY (1940)
Professor of English, New Jersey State Teachers College, Montclair

JOHN W. CHILDS (1942)
Professor of Education, Teachers College, Columbia University

HAROLD F. CLARK (1941, 1942, 1943)
Professor of Education, Teachers College, Columbia University

HALBERT L. DUNN (1940)
Chief Statistician, Division of Vital Statistics, Department of Commerce, Washington, D. C.

ISABEL GORDON (1943)
Teacher of English and Chairman of Integration Committee, Bronx High School of Science, New York City

WILLIAM W. GREULICH (1940)
Formerly Professor of Physical Anthropology and Director of Brush Foundation, Western Reserve School of Medicine
Now Professor of Anatomy, Stanford University School of Medicine

LENNOX GREY (1942)
Professor of English, Teachers College, Columbia University

ROBERT J. HAVIGHURST (1939, 1940)
Formerly Director, General Education Board, New York City
Now Professor of Education, University of Chicago

LANCELOT HOGBEN (1941)
Mason Professor of Zoology, University of Birmingham, England

ERLING M. HUNT (1940)
Professor of History, Teachers College, Columbia University

JOSEPH A. LAUWERYS (1938, 1939)
Lecturer and Tutor in Methods of Science in the University of London Institute of Education

CLYDE R. MILLER (1941)
Formerly Associate Professor of Education, Teachers College, Columbia University

HARRY L. SHAPIRO (1942)
Professor of Anthropology, Columbia University, and American Museum of Natural History, New York City

SHERWOOD L. WASHBURN (1943)
Formerly Columbia University Medical School
Now Associate Professor of Anthropology, University of Chicago

C. C. WILSON (1943)
Formerly Professor of Health Education, Teachers College, Columbia University
Now Professor of Health Education, Yale University School of Medicine

FELLOWS IN CURRICULUM WORKSHOPS

Some whose names appear as research associates also participated as fellows. Their names are not repeated here.

RAYMOND AGREN (1939, 1940, 1941, 1942)
Formerly at Edwin Denby High School, Detroit, Michigan
Now at Northeastern High School, Detroit, Michigan

MARION ARZT (1939)
Head of Science Department, Mark Keppel High School, Alhambra, California

F. R. BEMISDERFER (1940)
West Technical High School, Cleveland, Ohio

THEODORE BENJAMIN (1939, 1940, 1941, 1942)
Formerly at Bronx High School of Science, New York City

Now Head of Physical Sciences, DeWitt Clinton High School, New York City

EDITH BRECHBILL (1939, 1940)
Montgomery Blair High School, Silver Springs, Maryland

NORMAN CHRISTENSEN (1941, 1942)
New Trier High School, Winnetka, Illinois

SALVATORE CIMILLUCA (1942)
Benjamin Franklin High School, New York City

NORMAN DOLLOFF (1940–1941)
Formerly at Cranbrook School for Boys, Bloomfield Hills, Michigan
Now Instructor in Chemistry (part time), San Jose State College, San Jose, California

LOUISE G. DREHER (1940, 1941)
Olney High School, Philadelphia, Pennsylvania

HOWARD GAISER (1940, 1941)
James Ford Rhodes High School, Cleveland, Ohio

ROBERT HILL* (1941)
Cranbrook School for Boys, Bloomfield Hills, Michigan

EDGAR HOOPES (1940)
Taylor Alderdice High School, Pittsburgh, Pennsylvania

WILLIAM KILGORE (1939, 1940)
Formerly at Central High School, Washington, D. C.
Now Instructor in Physics, Wilson Teachers College, Washington, D. C.

ROBERT KING (1939, 1940, 1941)
Glens Falls Public Schools, Glens Falls, New York

PHILIP KOTLAR (1939, 1940, 1941, 1942)
Fieldston Ethical Culture School, New York City

J. H. KUZNER (1939)
General College, University of Florida, Gainesville, Florida

VEVA MCATEE (1939, 1942, 1943)
Director of Science, George Rogers Clark High School, Hammond, Indiana

* Deceased.

J. Gordon Manzer (1940, 1941, 1942)
Head of Science Department, Central High School, Trenton, New Jersey

Harold H. Metcalf (1939, 1940, 1942)
Formerly teacher of chemistry and Dean of Junior Boys, Oak Park-River Forest Township High School, Oak Park, Illinois
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Nathan A. Neal (1939, 1942)
Formerly at James Ford Rhodes High School, Cleveland, Ohio
Now Editor, High School Textbook Department, Harper & Brothers, New York City

Mervin E. Oakes (1939)
Instructor of Biology, Queens College, Flushing, New York

Carl Penny (1941)
Warren Junior High School, West Newton, Massachusetts

Robert Scidmore (1939)
Formerly in Public Schools, Ithaca, New York
Now Commander, United States Naval Reserve, Washington

Philip N. Powers (1939)
Formerly teacher of science, Stephens College, Columbia, Missouri
Now at Atomic Energy Commission, Washington, D. C.

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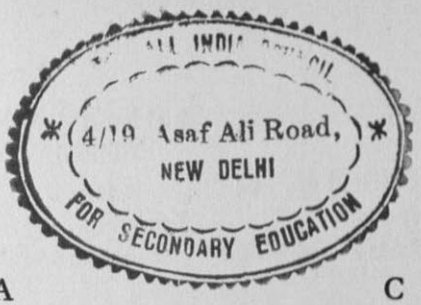

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